SURGERY, GYNECOLOGY AND OBSTETRICS

AN INTERNATIONAL MAGAZINE, PUBLISHED MONTHLY

VOLUME XLVI FEBRUARY, 1928 NUMBER 2

CHRONIC ULCER OF THE DUODENUM AND STOMACH[1]

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IN addition to chronic ulcer of the stomach, I will include in this paper chronic duodenal ulcer. I have always considered these conditions most interesting, in fact most fascinating. Although it is said that the question of treatment is not settled, still I feel that the accomplishments of surgery in treating these lesions, are, as a rule, most satisfactory. I believe that the gastro-enterologist, the internist, and certain surgeons who lack confidence in their work, are to a great extent responsible for the doubt as to the good accomplished by operative, as against medical, treatment. Personally, I can say, the longer I practice surgery, the more confidence I have in the surgical and the less in the medical treatment of chronic ulcer. The place which I give to the medical treatment of chronic ulcer is that before the diagnosis is definitely established. This statement is based on a study of the non-perforative as well as the perforative ulcers on which I have operated. Nearly all of these patients have had medical treatment for years before they came to operation. It is a reflection on the profession that so many people who many times have been pronounced cured of ulcer die from perforation of, or hæmorrhage from, a chronic ulcer. It is claimed that haemorrhage from an acute ulcer can be cured under medical treatment. This may be true for a large number of cases but not for all, for I have seen patients perish from hæmorrhage from an acute ulcer. It is also stated that recovery from hæmorrhage due to chronic ulcer takes place in the majority of instances. But again I say, this is not always so, for I have seen a number of cases that were medically treated to death. What I have just said is neither to discountenance medical treatment nor unduly to praise surgical treatment. but to give to each its proper merit. I have operated upon over 100 patients with perforated chronic ulcers, nearly all of whom had been treated medically for a number of years. In all such cases there was no question as to the presence of an ulcer as it was seen and palpated in the opened abdomen. I am not one who believes that the X-ray is infallible in the recognition of ulcer. I have often questioned the pre-operative diagnosis of ulcer on X-ray examination and have found at operation chronic cholecystitis with surrounding adhesions, or chronic appendicitis, or chronic pancreatitis, or, in a very few instances, viscer-optosis.

The diagnosis of bleeding ulcer is by no means always a correct one. Confusion may be caused by bleeding from multiple abrasions of the gastric mucosa, ulcerating œsophageal varices, Banti's disease, all of which goes to show that we must be on our guard.

In the last analysis, the type of surgical treatment will depend upon the type of ulcer, that is whether or not bleeding has occurred and whether or not the ulcer is attached to surrounding structures; its location, size, the

[1] Read before the Clinical Congress of the American College of Surgeons, Detroit, Michigan, October 4-7, 1927.

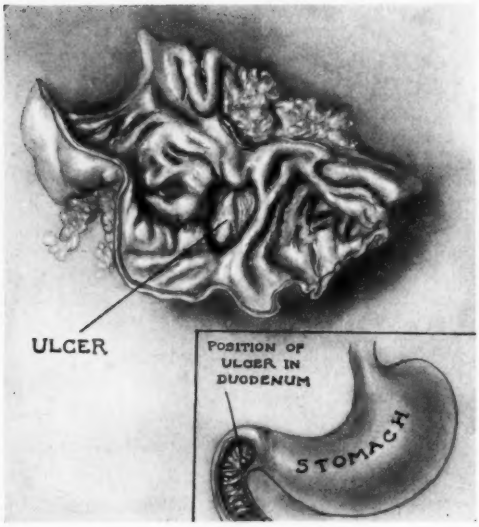

Fig. 1. Duodenal ulcer.

degree and character of the peri-ulcerous exudate, the size and depth of the crater. Unless very small the crater is made out by apposing the wall of the viscus opposite the site of the ulcer with the ulcer site. With the finger tip, the depression constituting the crater can then be readily felt.

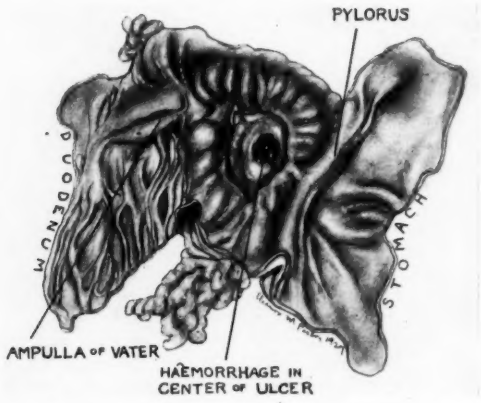

Fig. 2. Bleeding duodenal ulcer. Not operated.

For the small ulcer on the anterior wall of the first portion of the duodenum, a posterior gastro-enterostomy is usually the operation of choice, but if the operator is skilled and so prefers, a Balfour cautery removal or excision of the ulcer and a posterior gastro-enterostomy is ideal, although some surgeons consider a gastroduodenostomy or a Finney pyloroplasty the better procedure. For bleeding ulcer of the duodenum, if accessible, cautery destruction, or excision followed by posterior gastro-enterostomy is the proper method. But when the

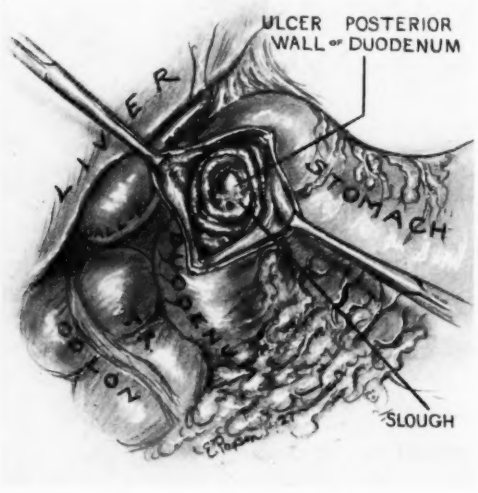

Fig. 3. Duodenal ulcer (posterior wall).

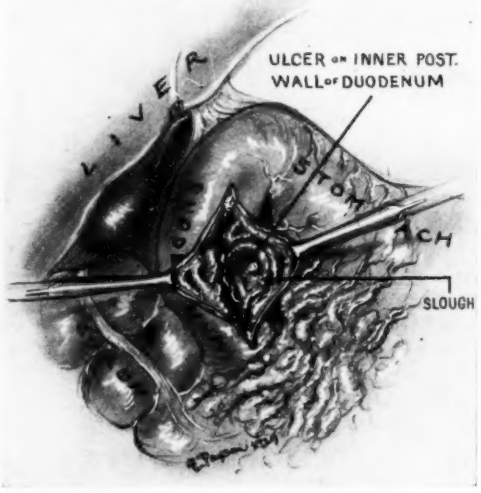

Fig. 4. Duodenal ulcer (inner posterior wall).

bleeding ulcer is not accessible for safe removal by cautery or excision, or when the peri-ulcerous exudate is too diffuse, the operation should consist of amputation of the duodenum below the site of the ulcer and the exudate, and removal of the pylorus. It is essential that along with the ulcer all of the peri-ulcerous exudate be removed and also by careful examination, that one make sure that there is not a second ulcer present. In the latter circumstances, I prefer a subtotal gastrectomy, although ordinarily I do not advocate subtotal gastrectomy except for gastric ulcer.

When the ulcer is on the posterior wall of the first portion of the duodenum, its recognition is more difficult. Here we must see well and palpate well, otherwise the ulcer will be missed. The recognition of exudate in the gastrohepatic or lesser omentum in juxtaposition to the duodenum is a signpost leading to the site of the ulcer which, with the detection of the crater, justifies the opening of the duodenum; then as the margins of the incised walls of the duodenal wound are retracted, the ulcer will be exposed. I place great value on the use of the Cameron light in these cases. In fact by this means I often am able to demonstrate the ulcer to the visitors in my clinic.

Fig. 6. Gastric ulcer of the lesser curvature. *A*. Chronic ulcer. *B*. Lines of the lesser curvature.

If the ulcer is located on the inner pancreatic wall of the second portion of the duodenum, only a posterior gastro-enterostomy is done, but if it be a bleeding ulcer, in addition to a

Fig. 7. Anterior anastomosis of the jejunum to resected stomach with a short loop.

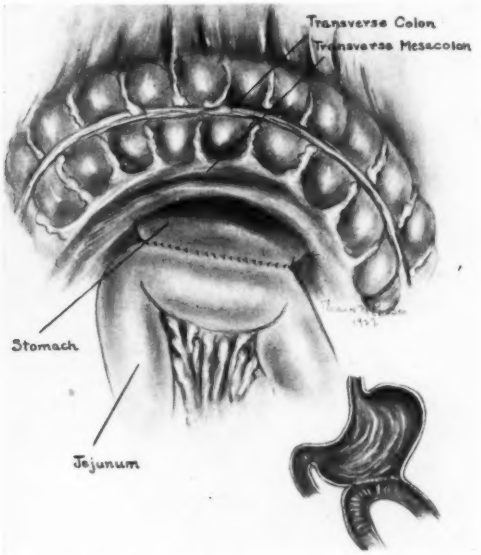

Fig. 8. Posterior gastro-enterostomy.

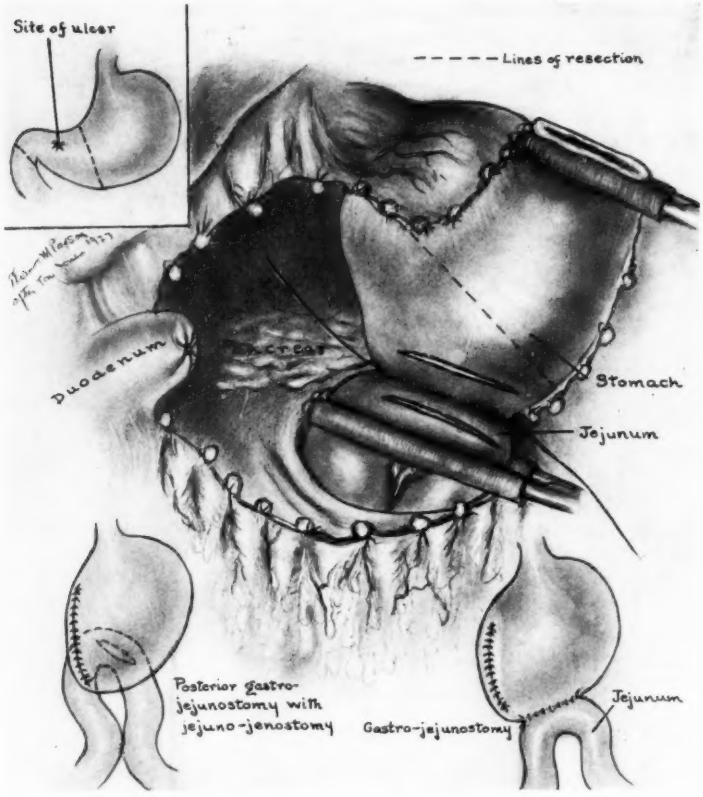

Fig. 9. Billroth II with posterior gastric jejunostomy.

posterior gastro-enterostomy, the duodenum should be opened, the ulcer cauterized but no attempt should be made to remove the ulcer.

From what I have said of duodenal ulcer and what I shall say of gastric ulcer, it will be seen that in the operative treatment of the duodenal ulcer, the surgeon has a greater choice of methods than for the treatment of gastric ulcer.

For gastric ulcer, with very few exceptions, I advise subtotal gastrectomy. A very small ulcer, with little or no peri-ulcerous exudate, located on or near the lesser curvature, on the anterior or posterior wall, can be excised and nothing more need be done. But if the lesion is on the lesser curvature and has caused hour-glass contraction, I now, on account of the danger of malignancy, usually do a subtotal resection where formerly I made a sleeve resection. Although I have done sleeve resection in a large number of such cases with most satisfactory immediate as well as remote results, I so firmly believe that gastric ulcer is frequently enough the forerunner of cancer, that I do the subtotal resection as a greater safeguard against cancer formation. In doing a subtotal gastrectomy, I find it easier to expose and ligate the coronary artery from behind than from above the stomach. This is accomplished by carrying the stomach well upward after it has been freed from the duodenum and the greater omentum. In ulcer of the cardiac end of the stomach, posterior gastro-enterostomy is the operation of choice.

The preferable type of subtotal resection is the Billroth II operation, and if the loops of

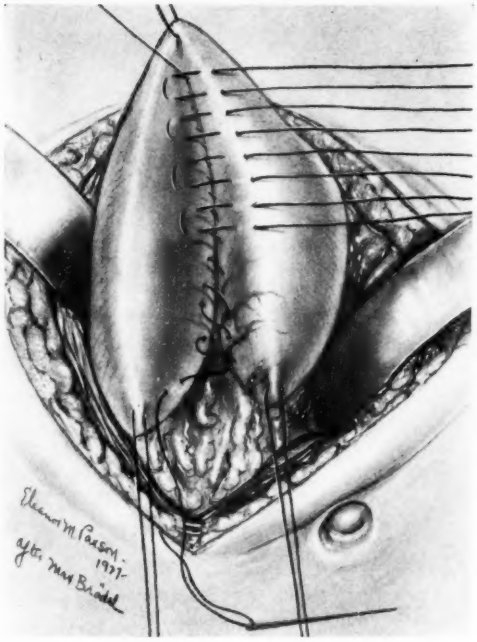

Fig. 10a. Finney pyloroplasty. Step 1.

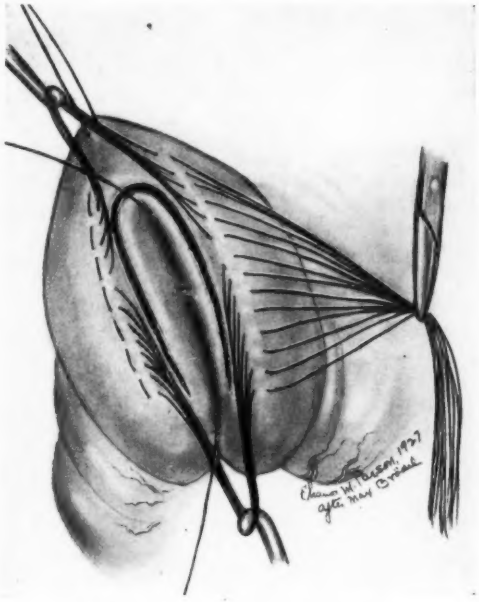

Fig. 10b. Finney pyloroplasty. Step 2.

Fig. 10c. Finney pyloroplasty. Step 3.

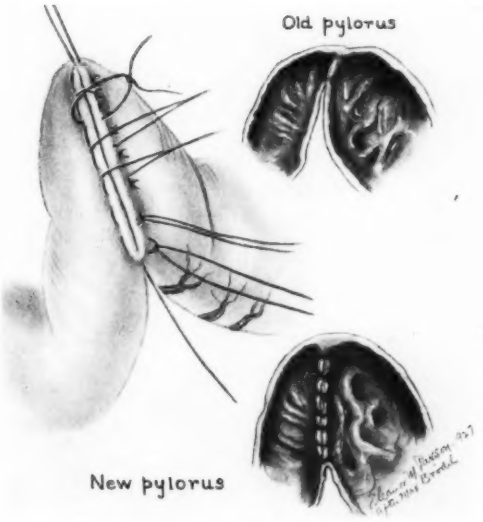

Fig. 10d. Finney pyloroplasty. Step 4.

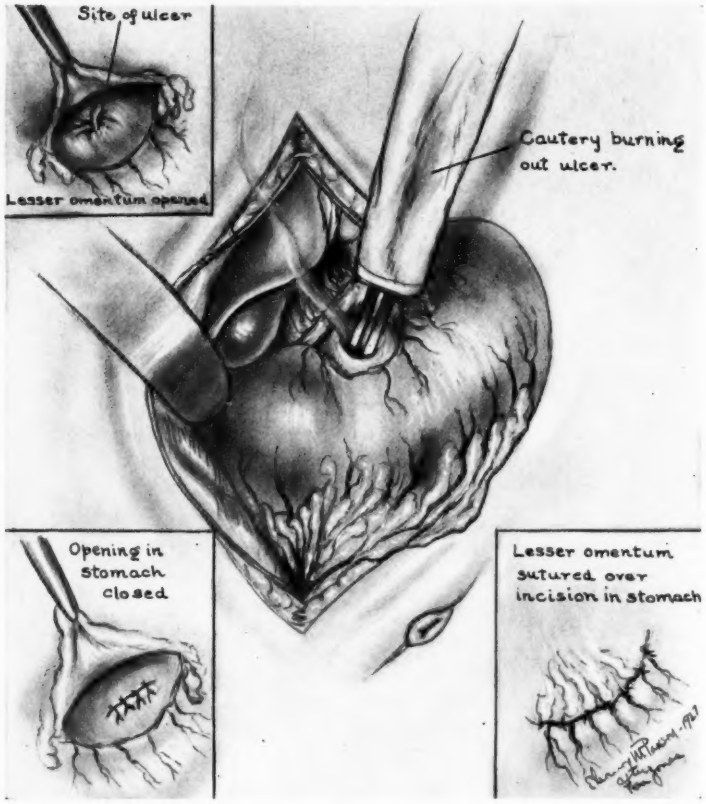
Site of ulcer
Lesser omentum opened
Cautery burning out ulcer.
Opening in stomach closed
Lesser omentum sutured over incision in stomach

Fig. 11. Balfour cautery excision of a gastric ulcer.

small intestines are left long, an entero-enterostomy can be done. The Moynihan operation with a short anterior loop, bringing the jejunum not far from its origin over the transverse colon and anastomosing the end of the stomach to the side of the jejunum is probably easier than the Billroth II, if a wide resection of the stomach has been made.

THE CONSIDERATION OF CONTOUR AS WELL AS FUNCTION IN OPERATIONS FOR ORGANIC ANKYLOSIS OF THE LOWER JAW[1]

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PREVIOUS to 1872, the common plan of treating ankylosis of the jaw was by forceful stretching or by excision of a section of bone from the angle or body. In 1858, an Englishman named George Murry Humphrey, excised an enlarged condyle of the lower jaw. However, the operation of excising one or both condyles for an ankylosis is usually credited to Bottini, who published his report[2] in 1872 (Fig. 1). Before 1900, almost every conceivable type of operation for this condition had been reported, even to removal of the jaw.

This subject is again brought to your attention, not in the belief that anything really new will be presented, but rather to emphasize certain factors, the detailed descriptions of which are rather meager or lacking in the literature, and also to bring out a few special points, which will be emphasized by citing appropriate cases.

MECHANICS

Excluding inflammations, tumors, fractures, and muscle spasm, chronic limitations of the movement of the lower jaw may be due to: (a) fibrous or bony changes of the joint itself (Figs. 1 and 2); (b) change in the shape or bony fixation of the ramus (Figs. 9d and e); (c) scars about the joint or in the cheek (Figs. 6a and b, Fig. 9); (d) infringement of a neighboring bony process (Fig. 5); (e) a combination of any of the above factors (Fig. 9).

OPEN OPERATION VERSUS FORCEFUL MANIPULATION

Though occasional successful instances have been reported, forceful dilation of a limited jaw opening of long standing, which has developed gradually, is seldom satisfactory and is not worth the effort involved (Fig. 1). For permanent relief the cause of the fixation must be eliminated or modified; the more accurate the pre-operative determination of this cause, the better and simpler will be the correction. Halfway measures may give relief much more lasting than simple stretching, but both are apt to be disappointing. Exposed scar bands should, where possible, be dissected out and replaced by a skin-bearing flap rather than simple incision with inlay Thiersch graft. In attempting correction by operation, it is, in most cases, better practice to remove the upper part or almost all of the ramus rather than to try to reconstruct the joint. The latter is a nice operation, but the former is much more apt to be successful.

EXTERNAL DEFORMITY

When the ankylosis has existed during the growing period and is due to a fixation within the joint itself, whether bony or fibrous, there will be some shortening of both the ramus and body on the affected side with a corresponding backward and lateral displacement of the chin (Figs. 2, 3, 18). If the fixation is unilateral and not complete, the chin will further deviate to the affected side when an attempt is made to open the mouth. This latter point may be helpful in determining which joint is fixed.

INCREASED ANTEROPOSTERIOR BREADTH OF THE RAMUS

If the limitation of movement is primarily due to scar bands that fix the lower to the upper jaw, the ramus may become abnormally broad from before backward. This might possibly be due to a failure of the anterior border of the ramus to be absorbed as is ordinarily concurrent with the normal growth of the lower jaw. In addition to this abnormal breadth the two jaws may be found fixed to each other by bony union (Figs. 9d and e). If the injury to the soft tissues happens after growth is completed, the subsequent scarring does not seem to cause these bone distortions

[2] See review of 82 cases treated before 1890, and 55 reported within the next decade. Surg., Gynec. & Obst., 1914, xx, 136–151.

[1] Presented before the American Surgical Association, May 6, 1925.

Fig. 1.

(Fig. 11a). Elimination of the scars with restoration of the soft tissues soon after injury may prevent this distorting growth of the bones (Fig. 12a).

RELATION OF CONDYLE TO NORMAL MOVEMENT

While the presence of a normal condyle is essential to the normal development of the mandible and of the temporo-mandibular joint, and to normal strength and stability and mobility of the mandible, still neither condyle is essential to useful function (Figs. 13a and b). The writer's own conclusion is that the lower jaw is hung in such a perfect muscular balance, that both condyles can

Fig. 2c. Fig. 2d.

be removed and, where desired, the jaw can be moved forward without seriously crippling function (Figs. 14 and 15). This latter point probably explains the universal success in the restoration of this joint obtained by the simple excision of sufficient bone with or without complicated efforts to furnish a substitute for the necessary joint surface. The writer has always attempted to interpose a fatty flap or superficial temporal fascia, not with the idea of placing a barrier between the bony surfaces, but to help fill the dead space that is left after removing the condyle (Fig. 7).

CORRECTION OF THE EXTERNAL DEFORMITY

That a plea should be made for the improvement of contour as well as for the restoration of movement is the chief aim of this paper (Figs. 6 to 15). Correction or improvement in appearance may be accomplished by one, or a combination, of several of the following procedures:

Fig. 2a.

Fig. 2b.

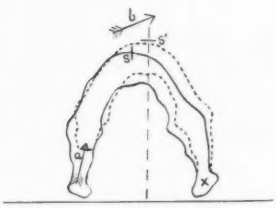


Fig. 3. *S*, symphysis; *S'* is point to which symphysis would move if it rotated to the midline with *X* as a center; arrows *a* and *b* show directions of movement.

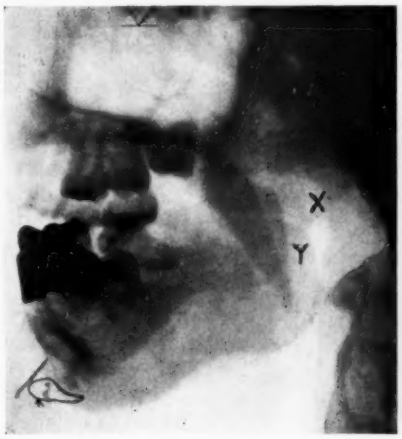


Fig. 4a.

Fig. 4b.

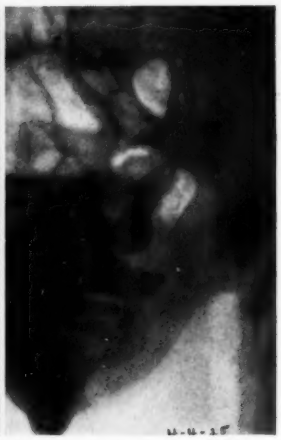


Fig. 4c.

1. After the fixed joint is freed the affected side of the mandible may be dragged forward and fixed in this position until the tendency to recede is overcome (Figs. 3, 7, 16, 17, 18). At first the fixation is made by interdental wiring, but later the pull of a rubber band may be used. In unilateral ankylosis, with a receding mandible, it may be necessary to section ramus of opposite side to get best attainable position of body of jaw (Fig. 4).

2. The receding chin can be built out by means of an implantation of costal cartilage (Figs. 7, 15, 17, 18).

Fig. 5.

3. The facial obliquity remaining after fixing the jaw bone in its new position can be rendered less noticeable by shifting the soft tissues of the chin laterally, by filling along the flat side of the jaw with cartilage or by a combination of these (Figs. 17a, d, and e).

TYPES OF CASES AND METHODS OF TREATMENT

Bony overgrowths about the joint—double resection and partial open bite. A blow on the face (Fig. 1) may be followed by an overgrowth of one or both condyles or of the neck and there may be an associated downward growth from the temporal bone. Any of these may distort the joint and limit movement without causing a true ankylosis. It was probably such a case that was originally operated upon by Humphrey. Figure 1, a roentgenogram taken in May, 1925, shows such an overgrowth. In 1912, at the age of 10 years, the patient was referred to us by Dr. C. H. Clay, with a history of previous good health, but at the age of 8 years she

Fig. 6a.

Fig. 6b.

Fig. 7a.

Fig. 7b.

Fig. 7c.

Fig. 8a.

Fig. 8b.

had fallen half a story onto her face. Three months before we saw her, she could not open her mouth freely, and at this time the symphysis was slightly to the right, the right lower cuspid being slightly behind the upper. The opening between upper and lower lateral incisors was 13 millimeters, the limit of movement was not sharply defined but could be forcefully stretched. In March, 1913, the opening was stretched to 3 centimeters and it was 22 millimeters 3 days after this operation. The child was kept under observation for 2 months with no decrease in the opening. She returned in March, 1925, with only a suggestion of movement. Both joints were then excised, including the condyles and the overhanging bone that arose from around the outer wall of the glenoid fossa. The mandible was dragged forward and fixed for 12 days, at which time the interdental wiring was removed. It was found that while movement was not paradoxical (Fig. 13), because of the elevation of the occlusial surface of the molars, there was a separation of the incisor teeth which would require further treatment.

This is the second case of ours in which, after the resection of both joints at once, there was a partial open bite in the incisor region and both followed early removal of the dental fixation. If the immediate restretching of the opening, and the rewiring of the teeth will not remedy this, it can be corrected by sectioning the ramus on each side below the site of the previous operation and then fixing the jaw in occlusion until bony union occurs.

Shortening of the ramus and retraction. Figures 2a and b. We have X-ray pictures of a child 3 years old who had gonorrhœal arthritis at birth resulting in an ankylosis on the left side. Figure 2a shows the left ramus and damaged joint. Notice that the developing sixth year molar, *a'*, is in the ramus and completely distal to the sixth year molar in the upper jaw, *b'*. On this side the ramus in the roentgenogram measured only 5 centimeters in its greatest length while in Figure 2b, the uninjured side, the relationship between the upper and lower sixth year molars is about natural and the ramus measures 6 centimeters.

Fig. 9a.

Fig. 9b.

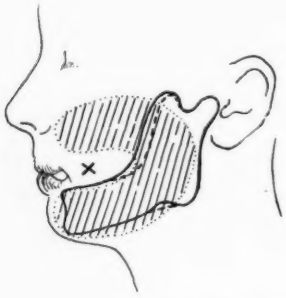
Fig. 9c.

Fig. 9d.

Fig. 9e.

Direction of rotation in bringing the jaw forward. Figure 3 is a diagrammatic representation of a lower jaw, short from before backward on the left side on account of an ankylosis of the left joint, which occurred during the growing period. After fixation was relieved, we were able to bring the symphysis forward and to the right by rotating the bone around the center which is at the right condyle. The left ramus will move in the direction of the arrow, *a*, the symphysis in the direction of the arrow, *b*. Note that the symphysis moves forward as well as toward the midline.

Section of the ramus to bring forward the body. The patient shown in Figures 4a, b, and c had scarlet fever and suppuration around the left temporal mandibular joint at 2 years. At 16 years she had extreme recession of the chin and inability to open the mouth. From lack of appreciation of the true mechanics of the condition, the writer, in February, 1908, cut both rami in two and dragged the body forward. This brought the chin into a better position but did not permanently cure the ankylosis. The result of this is shown in Figure 4a, which was taken late in 1908. *X* marks the posterior border



..... Indicates limits of Thiersch grafts.

//// Area grafted.

× Original flap that was placed in mouth ten years previously.

——— Outline of mandible showing increased breadth of ramus and notch below ramus.

- - - - - Approximate outline of average normal mandible.

Fig. 10.

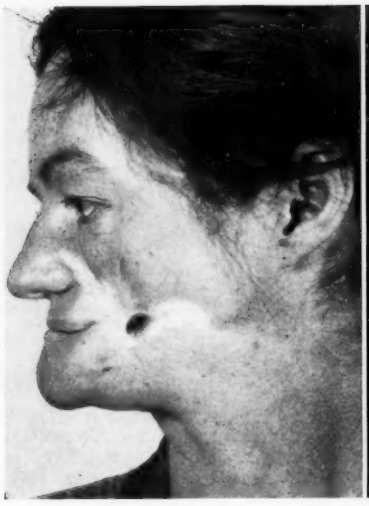


Fig. 11a.

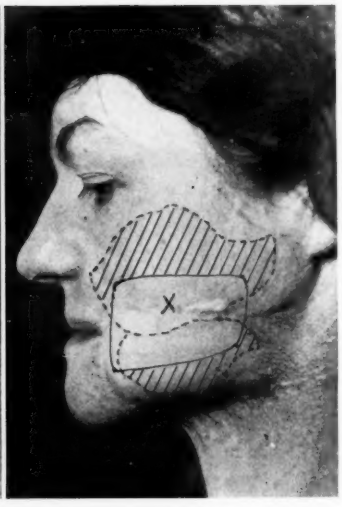


Fig. 11b.

Fig. 12a.

Fig. 12b.

of the upper part of the ramus dragged obliquely forward as the body was advanced. *Y* shows the ramus below the bone cut. The bone cut itself is indicated by the light line between these two. The resulting false joint later became fixed and the left condyle was therefore removed.

The proper procedure in this case would have been at the original operation to have removed the left condyle and cut through the right ramus. This would have restored movement and at the same time permitted bringing forward the jaw.

Figure 4b was taken in 1911 and Figure 4c in 1925. A study of the relations of the two last molar teeth will show there was a slight recession of this side of the jaw after removing the condyle. The wire and nail shown at the symphysis in Figure 4a are in a cartilage implant made in September, 1908, and in spite of some immediate suppuration, the cartilage has remained in place ever since. This type of cartilage fixation is not used any longer.

Limitation of movement, due partially to an overdeveloped styloid process that prevented normal backward excursion of the angle. Figure 5 is a roentgenogram of a 5-year-old patient who was crushed under a falling bale of hay and generally injured. Between the ages of 11 and 12 years, it was noticed that she could not open her mouth freely. Examination showed that the excursion of the lower jaw was limited and from that time on, the chin became relatively more receding and the downward excursion of the lower jaw lessened. When she consulted us, the patient was 21 years old, delicate and very thin. The mandible was undeveloped and the greatest possible vertical opening between the upper and lower incisor teeth was one-eighth of an inch. Because of the backward displacement of the jaw, the lower incisors were one-fourth inch behind the upper, which, with the one-eighth inch opening, gave a possible feeding space. We thought that the lack of development was related to the early injury, but this did not explain the limited movement which presented the following peculiarities: the movement was free until the opening between the incisor teeth was one-eighth of an inch and then stopped suddenly. During this movement the right condyle traveled forward as much as it would do in normal full opening of the mouth. The left remained apparently stationary and the chin moved to the left more than it did downward. This whole picture could be explained on the theory that there was a loose, fibrous ankylosis of the left joint and on that side the angle was prevented from moving backward by striking some firm object. A poor X-ray picture, the best available at this time, failed to throw light on this point.

The indications in this case were to give a free opening of the mouth, to establish a better occlusion of the teeth and to improve the profile by carrying the chin forward and holding it there. The rami were sawed transversely on both sides and the body of the jaw brought forward until the lower incisors were a little in front of the uppers and the chin

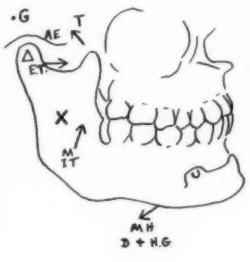


Fig. 13a.

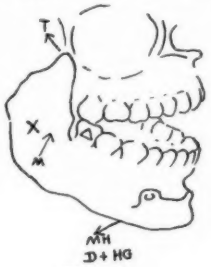


Fig. 13b.

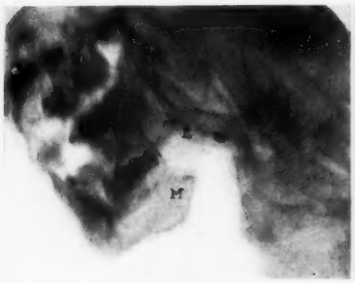


Fig. 14a.

Fig. 14b.

Fig. 14c.

Fig. 14a. *C*, coronoid process; *E*, articular eminence; *G*, rudimentary glenoid fossa; *M*, posterior end of body of mandible.

symmetrically placed. It was wired in this position. In 4 weeks the union was examined and found not to be strong, so the teeth were rewired for 8 weeks more. When the wires were removed from the teeth, it was found that the mouth opened freely one-half inch and that the limit of movement was some yielding structure. Examination, 1 year later, showed that the lateral movements were normal and the possible opening between the incisors was seven-eighths of an inch, which is sufficient for good function.

A good roentgenogram taken some years after the operation showed that the styloid process on the left side was almost the size of her little finger and at full opening abutted against the inner side of the angle of the jaw. It also showed a change about the left joint that suggested at least a fibrous ankylosis. This corresponded with the original deductions. When the body was moved forward, a space was obtained between the angle and the styloid process which gave room for the angle to travel backward and approximate normal movement.

Another patient had an arthritic fixation of the cervical spine with the head bent slightly forward, but even after the resecting of both condyles, the excursion of the mandible was still quite limited by the chin striking against the thyroid cartilage.

Scars about the joint preventing forward replacement. Unless the jaw is dragged forward and an interlocking occlusion established, the removal of the condyles will not correct the backward position of the body of the jaw (Figs. 6a and b).

Figure 6a shows a child, 5 years of age, with a close fibrous ankylosis of both joints, with a good deal of periarticular scarring, all due to an early infection of some kind. At operation, both condyles were resected, but on account of the scarring in the soft parts, it was impossible to move the body of the jaw forward.

Figure 6b shows the same child 1 year later, at which time she had a functional opening of the mouth.

Asymmetry associated with an early unilateral ankylosis. At the age of 6 years this patient (Figs. 7a, b, and c) had a tooth infection and necrosis of the jaw on the right side. At 24 years, when he came for treatment, the most noticeable points were lateral prominence of the body of the jaw toward the ankylosed side, with corresponding flattening on the opposite side, deviation of the chin, lips, and nose toward the affected side with obliquity of the mouth slit as compared with a line drawn through the palpebral fissures. The partial correction here

Fig. 15a.

Fig. 15b.

Fig. 15c.

Fig. 15d.

Fig. 15e.

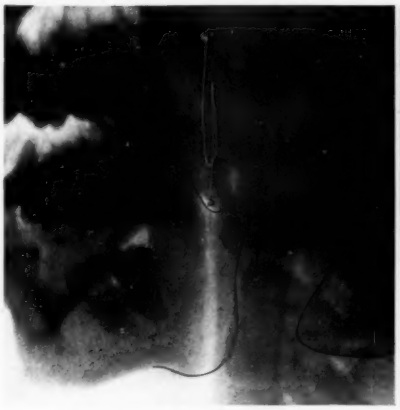


Fig. 15f.

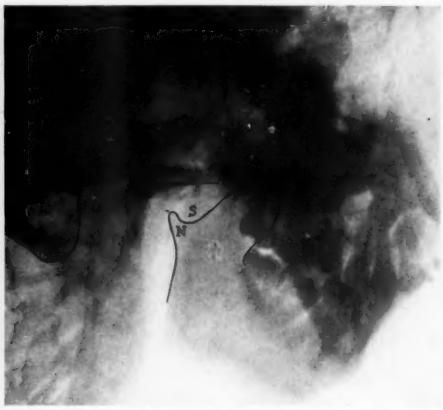


Fig. 15g.

Fig. 15f. *M*, mastoid process; *G*, glenoid fossa; *A.E.*, articular eminence; *N*, rudimentary neck; *S*, sigmoid notch; *C*, coronoid process.

shown was made by removing most of the right ramus and rotating the jaw bone to the left, shifting the soft tissues of the chin still farther to the left and implanting a cartilage. In this, the first case in which we attempted to move the soft tissues on the bone, the chin was brought to correspond almost with the axis of the nose, as shown in Figure 7b. A more acceptable result would possibly have been obtained if the chin had been brought nearer to a vertical line dropped from the mid-point between the brows at right angles to the axis of the palpebral fissures as was done in Figure 17e.

Figure 7c shows the large amount of the ramus that was removed to permit bringing forward the right side of the mandible. In the case shown in Figure 17, it was necessary to remove a still larger part of the ramus, including that part which held the roots of the third molar, before the mandible would clear the upper molar teeth. This large removal of the ramus seems to cause no functional inconvenience in a single resection but I believe it not permissible in a double ankylosis. In the latter case, I believe it is desirable to retain the coronoid process and temporal muscles.

Lateral deviation. A child 11 years old (Figs. 8a and b) who at 4½ years had meningitis, following which partial ankylosis gradually developed. Figure 8a shows the full extent of the opening when he came for operation; Figure 8b, the possible opening 16 days after removal of the condyle and upper half of the left ramus, but this opening should increase considerably in the next 3 months. The point brought out in this illustration is that the tendency, when the mouth is opened, for the chin to deviate to the resected side, still persists.

Scar fixation—late results. A woman 38 years of age (Figs. 9a, b, and c) was referred to us by Dr. W. C. Drummond. At 11 years she had probably a noma and lost part of the cheek, left upper lip, lining of the cheek and part of the left upper jawbone; when it healed she could not open her mouth. Figure 9a shows condition February, 1918, with mouth open to the fullest extent, 4 millimeters between upper and lower incisors. Figure 9b shows the extent of the opening after the removing of the upper end of the left ramus, the removing of the cheek scars and the replacing of lining and external cheek tissues with flap from forehead. The mouth would open, December 12, 1924, 2 centimeters between incisors, but this has increased since. Figures 9b and c were taken February 13, 1925. Figure 9d shows a normal joint, but a somewhat wide ramus and coronoid after 27 years of almost complete fixation. Figure 9c shows the left, the injured side,

Fig. 16a.

Fig. 16b.

Fig. 16c.

Fig. 16d.

with only relative growth changes about the joint itself, but with tremendous widening of the ramus and posterior part of the body. Originally the bony mass at the outer border of ramus or of the posterior part of the body had acquired bony union with the maxilla, but this was chiseled through at the original operation in 1918 by Dr. A. O. Fisher, and had not reunited. The joint changes shown on this side, in this figure, were a relatively small condyle and a very deep narrow glenoid fossa with a correspondingly high articular eminence. In the note on the 1918 operation, it is stated that after cutting the scars and cutting the bony union between the two jaws, the mouth could be forcefully opened 3 centimeters and was blocked in this position, but in 1924, after cutting all the reunited scar bands, we were not able to open the mouth until the joint and upper half of the ramus were removed.

Scar fixation—late results. In Figure 10 we have the photograph of a woman referred by Dr. H. R. Shands, who, in 1923, was 22 years of age. At 13, following typhoid fever, she had a noma which destroyed the lining and considerable of the surface of the left cheek. Following this, she could not open her mouth. Some time later the lining scar had been removed and the cheek lined with a flap turned from the neck, but she stated it did not relieve the fixation. When first seen by us, March 12, 1923, she had an opening between the incisors of 6 millimeters. Fixation apparently was due to a scar band in front of the cheek lining that had been obtained from the neck at the previous operation. However, a functional opening was not obtained until the abnormally wide ramus was removed and the cheek lining pieced out and the buccal and labial sulci were restored by means of thick Thiersch grafts inserted on 3 wax forms. *X* shows the area lined by the original neck flap. The shaded area shows the amount of lining that was obtained from the Thiersch grafts, but there is always considerable contraction of these thin free grafts for which provision has been made. The dotted line shows the profile of jaw bone bringing out the increased anteroposterior width of the ramus.[1]

The lower lip was subsequently raised by a flap thrown under the chin. Still further correction was done later by Dr. J. E. Johnson, of Memphis.

Scar fixation—later results. Figure 11a shows a woman 36 years old, referred by Dr. Royal Wight. Seven years previously, following the extraction of an infected tooth in the acute stage of the inflammation, she had a necrosis of the bones and considerable loss of the soft tissues. The edentulous gums are held almost in contact by the cheek scar. Compare with Figure 11b and notice in Figure 11a that the distance from nose to chin is much shorter and besides the hole in the cheek and its scarring, the corner of the mouth is drawn up and back. In this case, as the injury occurred after the bones had ceased to grow, there was no great deformity of the ramus and joint, and the correction consisted only in the release of the scars and the replacement of the destroyed soft tissues. This was done by first throwing a double pedicle flap from the neck to line and cover the cheek and then later by restoring the upper and lower sulci by Thiersch grafts put in on wax forms. The oblong area *X* in Figure 11b indicates the position of the lining flap derived from the neck, the dotted lines outline the wax forms and the striped surface, the extent of the areas covered with the inlay Thiersch grafts. These two procedures enabled her to open the mouth sufficiently for function and also to wear complete upper and lower dentures. Notice the difference in outline of lips and chin as shown in Figure 11a.

Dense cheek scars causing ankylosis. Figures 12a and b show a child of 8 years in whom, after a gangrenous stomatitis at 5 years and several ineffective

[1] See surgical restoration of the lining of the mouth. Surg., Gynec. & Obst., 1925, xl, 165–174.

Fig. 17a.

Fig. 17b.

Fig. 17c.

operations, the upper and lower jaws remained bound together by scars throughout the substance of the cheek that extended from the anterior border of the ramus to the cuspid region. In this patient the restoration of the cheek was made before serious changes in the shape of the bone had occurred, and therefore no bone operation was necessary to restore movement.

Paradoxical movement. In Figure 13a we show a diagrammatic representation of the normal jaws, *X* indicating the axis of motion in the simple opening and closing. *G* glenoid fossa and *A.E.* the articular eminence which together indirectly form a bearing or guide for the condyle during this movement. *T*, approximately the direction of pull of the temporal muscle in closing the jaw. *I.T.M.* approximately the direction of pull of the internal pterygoid and masseter muscles in closing jaw. *E.T.* approximately the direction of pull of the external pterygoid in opening the jaw. *M.H.D.* and *H.G.*, approximately the direction of pull of the mylohyoid, digastric and geniohyoid muscles in opening jaw. If *G.A.E.* is a bearing, then the △ on the condyle would represent the fulcrum, the arrow *M.I.T.* approximately the power, and the teeth the load, of a lever of the third class. This is approximately true in ordinary movements of the normal jaw. If a bearing for the condyle at *G.A.E.* were essential to this motion, then on removal of the condyle, the molar teeth being present, the mandible would be converted into a lever of the first class with the load anterior to the fulcrum (△) and the power *M.I.T.* behind the fulcrum; contraction of the muscles of mastication would then draw downward that part of the jaw that is in front of this new fulcrum. In this condition *X*, the axis of movement and △ the fulcrum correspond. On these theoretical grounds we long hesitated to remove both condyles in a double ankylosis until the analysis of reported cases showed that it was not always followed by open bite. It is something of this fear that probably causes men to limit the operation to those cases in which the joint can be reconstructed—an operation less apt to be successful than is a free removal of bone and also it is an operation with a very much more limited field of accomplishment. Our own subsequent experience has shown that these theoretical fears are not entirely groundless. If both condyles are removed at one operation and the upper and lower teeth are not fixed together, contraction of the masticatory muscles will cause an opening between the incisor teeth and permanent open bite may result. We have had this happen in 2 cases when the

Fig. 17d.

Fig. 17e.

Fig. 18a.

Fig. 18b.

Fig. 18c.

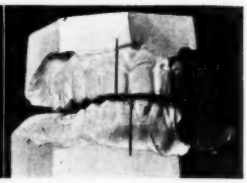


Fig. 18d.

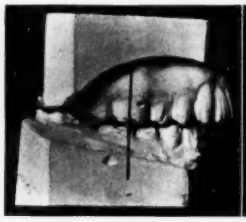


Fig. 18e.

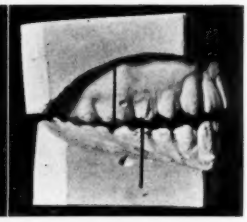


Fig. 18f.

dental fixation was removed at the end of 3 weeks. In 1 child, however, in which the condyles were removed at 18 months (Fig. 14) due to lack of teeth, no fixation of any kind was used and no paradoxical movement resulted. In other cases in which dental fixation was retained sufficiently long, 8 to 12 weeks, a muscular balance was established that can closely similate normal movement, even when there is no bony contact between the mandible and skull behind the occluding teeth, the axis of motion remaining approximately normal.

Muscular balance. In Figures 14a and b we have X-ray pictures of the ramus and joint regions of a child who 5 years previously, at 18 months of age, lost both condyles from infection following bilateral fracture at the junction of the necks with the rami.

Figure 14c is an outline drawing of an average 18 months' mandible showing the lack of development of the ramus at this age and also the approximate line of the fracture in this case.

In Figures 14a and b, roentgenograms taken 5 years later, it will be seen that, following the loss of the condyles there has been little or no subsequent development of the rami, and though the coronoid processes have become abnormally long, so that the tips approximate the normal point of insertion of the temporal muscles, these long coronoid processes have failed to migrate backward to a normal extent as proved by the shortness of the body and also by the fact that the twelfth year molar is seen developing in the base of each.[1]

In this child the body of the lower jaw is in a somewhat posterior position, but she can open and close, move jaw to either side and chew her food satisfactorily, but as demonstrated by the X-ray picture she has no bony contact between the mandible and the base of the skull. The chief disability resulting from this condition is that neither this patient, nor one other similar one, can sleep lying on the back, for then, the muscles being relaxed, the jaw with the tongue drops backward and shuts off the pharyngeal airway.

Second case illustrating a functional end-result without bony contact. Traced profiles of a girl who at 7 years had an auto injury leaving a scar on the chin, and was never afterward able to open her mouth, are shown in Figures 15a, b, and c. When referred for treatment in August, 1915, by Dr. A. H. Hammel, she, then 13 years of age, had a complete bilateral bony ankylosis with typical retracted lower jaw as shown in Figure 15a. Both condyles were removed, and the dead space was filled with flaps of fat and fascia from the temporal regions. At the same time, the body of the jaw was drawn forward until the lower incisors were 4 millimeters in front of the uppers and the jaws thus fixed by interdental wires. This gave the immediate profile (Fig. 15b). The interdental wiring was retained for 12 weeks and when the fixation was removed she had all natural jaw movements, but these movements were not all normal. At a later period, Dr. L. R. Main extracted the first lower premolar on each side and drew back the cuspids and incisors into normal occlusion with their opponents. This gave her a rather acceptable facial outline, but with later growth the lower jaw failed to retain its harmonious relation with the upper and at 18 she again had a relatively receding chin as seen in Figure 15c. Five years after the first operation she had an opening of 26 millimeters.

Figures 15d and e show the same girl at the age of 18 years, before and after inserting a piece of costal cartilage in front of the mental eminence.

Figures 15f and g are from stereoscopic X-ray films, *f* the right joint region and *g* the left. *M* is the mastoid process; *G*, the glenoid fossa; *A.E.*, the articular eminence; *N*, the rudimentary neck of the amputated condyle; *S*, the sigmoid notch; *C*, the abnormally large coronoid process. Comparing this area with corresponding area in Figures 14a and b, it will be observed that a subnormally developed ramus is present in the child who was injured at 7 years while it is entirely absent in the child who lost her condyles at 18 months. Further, that while in the younger child, at the age of 6 years, the twelfth year molar is developing in the base of the coronoid, in the girl of 18 years, who was injured at 7 and lost

[1] See Theory of migration of the ramus after Hunter. Blair: Surgery and Diseases of the Mouth and Jaws, p. 284.

her condyles at 13, the third molar has erupted in front of the ramus (and base of the coronoid).

In the stereoscope it is very easy to verify all of these points. By noting the relation of the ramus and the condylar neck, *N*, to the glenoid, *G*, and the eminence *A.E.*, it will be seen that the jaw has no bony bearing on the base of the skull, and that it has remained in the forward position, given to it at the ankylosis operation 5 years previously. The movements are similar to those described under Figures 14a and b.[1]

Preangular notch. Retraction of the chin is rather a constant accompaniment of an ankylosis developed during the growing period and is often much more pronounced when the face is viewed in profile than would be indicated from the occlusion of the teeth (Figs. 16a, b, c, and d). On the other hand, facial symmetry is extremely variable.

This 15-year-old girl had a fall at 5 years, and 6 months later it was noticed that the mouth did not open freely. After the left joint was resected, the jaw was swung to the right until the symphysis was brought to the midline. This helped the profile very little and 16 days later a cartilage implant was made into the chin. In making these implants, we usually use a piece of the left eighth costal cartilage, preserving as much of the perichondrium as possible. Figures 16a and b show the profiles before the first operation and after the cartilage implant. Figure 16c shows the normal joint ramus and angle. There is a characteristic notch at the lower border of the jaw just in front of the angle on the ankylosed side, whether it be single or double (Fig. 16d). In almost all cases of partial, single ankylosis, the chin deviates toward the ankylosed joint, as the limit of excursion is approached. In this case, for some unrecognized reason, the latter sign was absent and there was no thickening to be felt about the affected joint, but in spite of all this and without an X-ray examination, one could have recognized, in this case, which was the affected joint by the presence of the notch on that side. This roentgenogram shows the broad contact of the fibrous ankylosis, the shorter ramus, and the characteristic notch in front of the angle.

Correction of external deformity. For putting all one has into a case, one may be amply repaid (Figs. 17a, b, c, and d). This young lady, referred by Dr. A. B. Kanavel, came at the age of 18 with the history of scarlet fever and discharging ears at the age of 4 months and a left mastoid operation at 2 years. Six months later the mouth opening was limited and the chin already deviated to the left. She had had orthodontic work for 10 years and had one fat transplant into chin, as evidenced by the scar in Figure 17a.

[1] These observations upon the movements of the mandible minus condyles have been the subject of close study by us for a number of years, and the ideas here presented were formulated quite some time ago and later seemed to be confirmed by the movements and X-ray examination of case shown in Figure 15, but their publication was withheld until another confirmatory case with as complete data could be studied. The full record of Figure 14 has only lately been completed.

Figures 17a and d show the characteristic deformities. In order to get clearance for moving that side of the mandible, the whole of the left ramus was removed and the jaw was then shifted as far as possible forward and to the right where it was held by interdental wiring. Two months later, through an incision made just under the chin, the thickest obtainable piece of cartilage was implanted in front of the chin, and a long wedge-shaped piece slid along the right side of the body, the soft tissues at the same time being shifted to the right and sutured in this position.

Figures 17c and e show the result. Notice the mouth line has been made horizontal, the chin is approximately in the midline, the left cheek is less prominent, and the very deforming flatness on the right side of the lower jaw is almost obliterated.

Figure 17a shows the profile before the joint resection and the scar of a previous operation.

Fig. 17b, superimposed tracings, made from the negatives showing the condition before the first operation, after bringing the bone forward and after the cartilage implantation. Notice in Figure 17c how the lower lip and corner of the mouth have been lifted. When she left the city, she had an incisor opening of 2.5 centimeters which will still further improve. The space between the lower central incisors was 3 millimeters to the right of the midline above.

Correction of external deformity. Figure 18a shows the appearance of a young man who had rickets in infancy; but there was no evident causative factor for ankylosis elicited. At 16 years of age, he went to an orthodontist and it was found that he could not open his mouth freely. The facial asymmetry became more evident with subsequent growth. When referred to us by Dr. C. A. Thigpen of Montgomery, Alabama, he was 20 years of age. The chin was well over to the right, as shown in Figure 18a, and there was a free opening between the upper and lower incisors of 1.5 centimeters. The chin was quite receding. An X-ray picture showed fibrous ankylosis of the right joint. At operation, June 24, 1924, most of the right ramus was removed, and the jaw dragged forward and the jaws fixed with a pine block between the upper and lower molars on right side with an incisor opening of '3 centimeters. Block and wiring were removed 16 days later and subsequently Dr. J. H. Williams put on an orthodontic appliance with a rubber band that drew the right body farther forward and to the left than it was when the block and wires were removed. Figure 18b shows appearance 4 months later. His chin and mouth are still slightly to the right, but if a cartilage were implanted the soft tissues would be shifted to the midline as was done in Figure 17, and his profile much improved. Figures 18c, d, e, and f show the amount of shifting of the lower jaw that was accomplished by dragging the right side of the body forward at the time of the ankylosis operation.

COLLOID CARCINOMA OF THE STOMACH[1]

By JOHN W. STINSON, M.D., F.A.C.S., Rochester, Minnesota
The Mayo Foundation

BRINTON was the first to make a statistical investigation of gastric carcinoma. He reviewed much valuable data from various sources, and published his records about 1857. His analysis of these cases is of considerable value even today.

Much doubt has existed concerning the relative malignancy of colloid carcinoma. It has been designated variously as mucoid, gelatinous, and myxomatous, and may occur normally in every organ producing or capable of producing mucus. The most common sites of colloid carcinoma are the stomach, large bowel, and appendix, but occasionally it occurs in the gall bladder, bronchus, breast, ovary, cervix, urinary bladder, kidney, and salivary glands.

Certain investigators regard colloid as a consequence of degeneration, and others as a secretion, but the latest and most accepted view is that it comes from the epithelial cells of the carcinoma. This has been particularly noted both in the primary and metastatic growths. My studies seemingly corroborate this, and also seem to show that the colloid originates from the epithelial cells as a secretion, and is not a result of degeneration. There are many instances of specimens from carcinomata showing isolated areas of cells with a small amount of colloid formation, and many of the cells themselves may be seen to contain colloid, the nucleus being pushed to one side, giving a signet-ring appearance. Some of the cells may have ruptured showing that the colloid apparently caused too much pressure. The finding of small deposits of colloid in the epithelial cells of carcinoma, and in no other cells of the tumor, suggests its probable origin from epithelium.

Colloid in carcinoma is said to be a mixture of mucin and other proteins derived from cell degeneration and vascular exudates. Wells says that mucin appears chiefly in two localities: in the epithelial cells, as a product of secretion, and in the interstices of connective tissue, especially of tendons. There is also evidence that mucin or a related body constitutes the cement substance between all body cells. Corresponding to these two chief sources of mucin, mucoid degeneration occurs as a distinct process in mucous membrane, or tissues derived therefrom, and in connective tissue.

Wells further states that in its typical form, mucin is a compound protein consisting of a protein radical and a conjugated sulphuric acid which contains nitrogenous sugar. It is acid in reaction, probably because of the presence of sulphuric acid, and when boiled with acid, yields a substance which reduces Fehling's solution. It is characterized microchemically by staining with basic dyes. It is readily dissolved in weak alkaline solution and is precipitated by acetic acid.

Epithelial mucin represents a distinct product of specialized cells. Mucin formation of catarrhal inflammation is merely an excess of normal secretion and degenerative changes that may be present in the epithelial cells. Even in the extreme example of mucoid change seen in carcinoma derived from mucous membrane, for example, colloid carcinoma, the epithelial change is not necessarily to be interpreted as a conversion of cell cytoplasm into mucin but is largely due to pressure of secreted mucin on the cells within the confined spaces of the tumor. This mucin is the same as the normal mucin coming from the same source but mixed with larger or smaller quantities of other proteins derived from cell degeneration or from vascular exudates.

From March 1, 1913, to May 1, 1925, there were 2,516 pathologically proved cases of carcinoma of the stomach examined at the Mayo Clinic and of these, 121 were of the colloid variety; the latter form the basis for the present study.

INCIDENCE

The following data, beginning with Brinton's first statistical studies and including some of the largest series studied by various

[1]Abridgment of thesis submitted to the Faculty of the Graduate School of the University of Minnesota in partial fulfillment of the requirements for the degree of Master of Science in Surgery, February, 1926.

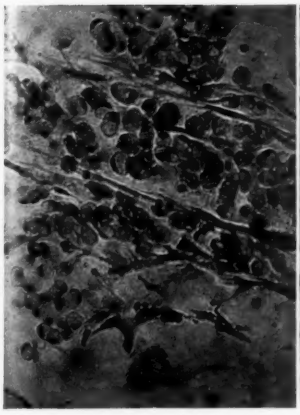


Fig. 1. "Signet-ring" cells of colloid carcinoma. (×150)

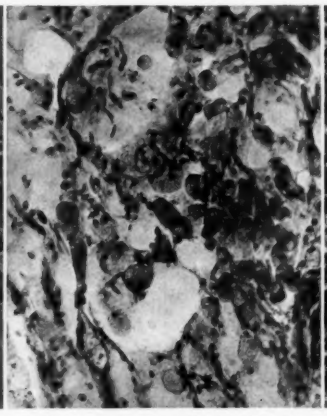


Fig. 2. Area of colloid and a few signet-ring cells. (×120)

Fig. 3. Diffuse infiltration of colloid carcinoma. (×120)

observers, give the incidence in relation to the other types of gastric carcinoma as well as to other malignant growths of the gastro-intestinal tract. In Brinton's series of 135 cases of carcinoma of the stomach, 9.4 per cent were of the colloid type. Welch, in a review of 1,221 malignant growths of the gastro-intestinal tract, noted colloid carcinoma in 2.5 per cent, and von Klein in 395 cases noted the colloid variety in 5 per cent. Parham, in a review of 784 cases of gastric carcinoma, found them in 6.5 per cent. In my series of 2,516 cases of gastric carcinoma, colloid changes were found in 5.09 per cent. In all of my cases, the tissue examined microscopically was obtained at operation or at biopsy; thus all cases were verified pathologically.

SYMPTOMS

There was nothing in the histories that could be used to differentiate, with any degree of accuracy, the colloid carcinomata from other types of gastric carcinoma. Exploratory operation and microscopic examination of tissue offer the only sure method of differentiation. The average length of time (preoperative) that patients in this group complained of symptoms was 8½ months.

SEX AND AGE

There were 25 women and 96 men in the series. The average age of the women was 50.5 years; of the men 53.3 years: the general average was 52.7 years. The oldest patient was 79 and the youngest 31 years of age.

PATHOLOGY

The structure of colloid carcinoma of the stomach is similar to that of ordinary adenocarcinoma except that a great deal of thin mucus is present. Many of the lesions, especially the larger ones, when first viewed at operation, are readily recognized because the colloid material is frequently subserous. If the serosa is involved the surface over the lesion presents the small, clear, tapioca-like masses which are typical of this variety of carcinoma. The stroma is translucent and gelatinous, either colorless or light brown. The lumen of the stomach often presents a large flat ulceration and in the smaller ulcerations where colloid is not so prominent the craters are frequently deeper. Here is seen a distinct alveolar grayish framework which encloses the colloid granules. In the typical cases, all of the wall of the stomach from mucosa to serosa is almost completely changed by the presence of colloid material so that the cut surface is clear and gelatinous and of a soft friable more or less mushy consistency. In these cases practically all of the involved area of the stomach is replaced by colloid which frequently produces a somewhat honeycomb effect.

There were no complete perforations in the series of cases studied, instead the whole wall

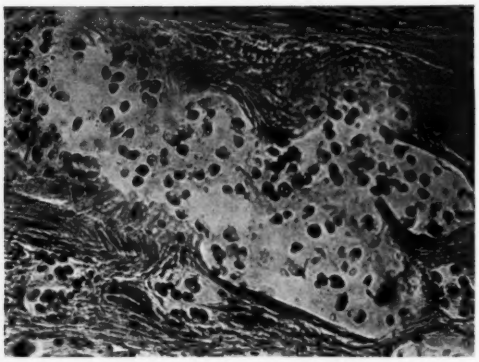


Fig. 4. Isolated area of colloid material with a few signet-ring cells. (×120)

of the stomach was usually thickened as in the scirrhous type of carcinoma. Even in the smaller deeper ulcerations the danger from perforation seemed negligible. When the craters were deep and the gastric wall therefore somewhat thinner, the adhesions and thickening immediately surrounding made danger from perforation improbable. There seemed to be a constant regenerative process about the areas of ulceration and destruction.

Most of the lesions were situated at or near the pyloric end of the stomach, but many of them were so large that the ulceration extended past the middle of the stomach. In many of the typical cases the line of demarcation of colloid and normal appearing tissue is very abrupt. Grossly the colloid appears to have destroyed the normal tissue or substituted tissue in its place. Often the muscle is of normal consistency up to the edge of the cancer; then it appears to be completely changed to the colloid type.

The stomachs showing colloid on the serosa were, for the most part, those containing the larger lesions. In some cases the colloid was plainly visible when the stomach was opened, or was presented grossly on the mucous surface when there was no indication of its presence on the serous surface.

Colloid changes may be noted in the earliest stages of the carcinomatous process and are frequently found on microscopic examination when not visible grossly. This is true particularly of the smaller ulcerations when there is a question of simple benign ulcer or carcinoma. The association of ulcer and cancer is so frequent that the possibility of malignancy should always be considered with any ulceration of the stomach. MacCarty (6) believes that most chronic gastric ulcers with a diameter of 2.5 centimeters are cancerous. Grossly the colloid ulcerations vary from 1 to 14 centimeters in diameter. Some are rather small lesions that appear as simple, benign gastric ulcers and their true nature can be detected only by microscopic examination. There are no instances in this series of cases in which

Fig. 5. Large shallow crater. Wall of the stomach nearly destroyed by colloid material.

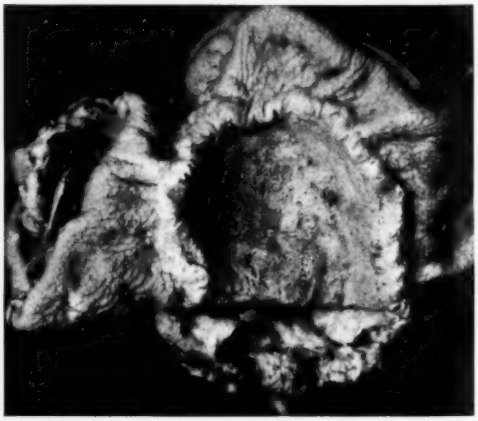


Fig. 6. Deep crater showing a large amount of colloid material.

cancer existed without some evidence of its presence in the mucosa.

At operation many cases showed general carcinomatosis, metastasis taking place as in other types of gastric carcinoma, but in addition colloid globules were often found. In many instances the omentum was so extensively affected as to be thickened and board-like.

On microscopic examination, typical colloid carcinoma presents a fine, connective tissue, alveolar frame-work containing a transparent mucocolloid mass. There may not be cellular elements but usually a number of cells or cell fragments are found. In many specimens the cells themselves are filled with the colloid material, the nucleus being pushed to one side, giving a signet-ring appearance. Frequently many cells are seen in a swollen condition and containing hyaline granules.

In certain cases colloid is found only after diligent search, and then in small amounts in isolated areas. Some of the more typical colloid carcinomata present a honeycomb appearance, the larger part of the tissue being completely replaced by colloid material. Colloid appears to stream out from the mucosa to the serosa carrying everything before it. It may be so much in prominence that practically no cells are contained in the meshwork enclosing it. Some areas show meshwork broken as if from the pressure of the colloid within pushing its way between other structures and causing more destruction.

In some specimens the colloid is found in isolated areas with many signet-ring types of cells, whereas a little farther away the signet-ring variety disappears and the typical adenocarcinoma type prevails without evidence of colloid formation. These malignant cells, entirely without colloid production, may account for the reported instances of metastatic recurrence in which colloid could not be demonstrated. These cells are the most malignant and therefore might have a greater tendency to metastasize. Another possible explanation for the areas of metastasis in which there is no colloid may be found in the results of the experiments of Lim and Cadé.

Lim, in his studies on animals, found evidence to show that the gastric glands are in

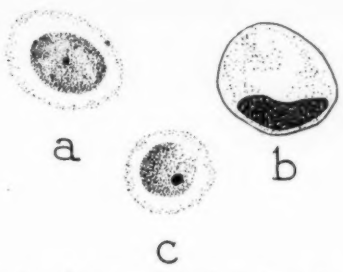


Fig. 7. Normal regenerative cell, *a*; signet-ring type of cell frequently present in colloid cancer, *b*; malignant cell, *c*.

the first instance formed of non-mucoid cells. Later these cells become mucoid throughout the stomach. The next type to differentiate is the oxyntic and at a later stage the peptic. Peptic cells are present in the stomach of the human fetus at birth. Obviously pepsin is not secreted by the mucoid cell.

Cadé found that oxyntic cells disappear and peptic cells lose their granules in the vicinity of gastro-enterostomy openings, and all the cells appear to be mucoid in character. He inferred from this that the altered conditions had caused the specialized cells to revert to the more primitive mucoid cells.

From the foregoing one might also infer that possibly some of the instances of metastasis in which colloid could not be demontrated might mean a reversion to the primitive or non-mucoid cell.

TREATMENT

Brinton in 1857 said: "Of the treatment, we will speak little because there isn't any of any value." The first step toward any plan of treatment was made by Pean, a Frenchman, in 1879, who removed the pylorus and the patient died. The first successful pylorectomy was performed by Billroth in 1881 and from this success came the first hope with regard to the treatment of carcinoma of the stomach.

In competent hands the operation of partial gastrectomy for carcinoma can be accomplished with a mortality rate of less than 10 per cent. In cases in which there is no operative interference, the mortality rate, so far as we know, is 100 per cent. Operation affords the only chance and in the proper surroundings should be undertaken. The earlier the

growth is seen the better is the chance of a cure.

OPERABILITY

After the general condition of the patient has been considered and the proper preoperative measures carried out in order that an operative procedure may be undertaken with the least possible risk, the vital question arises: Can all of the growth be removed? A thorough knowledge of the usual metastatic routes of gastric carcinoma is most essential before any type of treatment is instituted. If there is no external evidence of extension of the process, especially the evidence most frequently recognized clinically, such as supraclavicular lymph nodes of the left side, umbilicus, rectal shelf and chest, and metastatic areas are not detected on palpation of the other viscera, a thorough exploration of the abdomen must be made after the stomach has been exposed and the diagnosis verified. The viscera, especially the liver, peritoneum, and pelvic organs, should be carefully examined for nodules and then a most sedulous investigation made for lymphatic involvement along the usual routes of lymphatic drainage from the stomach.

Moynihan gives an excellent account of the lymphatic drainage from the stomach, the usual sites being classified as primary and secondary. "Primary" represents the lymph nodes immediately around the stomach, for example, the lower and upper coronary, the right paracardinal, suprapyloric, right suprapancreatic, gastro-epiploic, upper and lower, and the retropyloric when present. "Secondary" represents the lymph nodes more remote from the stomach; if these are involved the condition may be regarded as inoperable.

Primary lymphatic involvement is the most important to the surgeon because these lymph nodes receive vessels directly from the stomach and should be removed with the growth. Lymphatic invasion occurs early in gastric carcinoma and usually along the lesser curvature. The most important of the secondary lymph nodes are those around the cœliac axis, because they are the recipients of afferent vessels from all the groups previously described. They are few in number, large in size and lie in the fork formed by the coronary and splenic arteries as they arise from the cœliac axis. Some of them pass behind the pancreas to the lymph nodes lying at the root of the mesentery and if involved are readily palpable.

In a case in which the lymphatics appear to be more involved than usual but in which the case is otherwise operable, a microscopic examination of the nodes is often of service, because they are frequently found to be inflammatory, hence what would appear to be an inoperable condition is sometimes found to be quite the opposite. The early and wide extension into the submucosa is clearly seen in sections of the margin of the growth and for this reason the excision should be wide of the margin, never under 3 centimeters.

In this series of 121 cases of colloid carcinoma, 97 (80 per cent) were found to be operable, and the growth was removed. Nineteen were inoperable and 5 were suitable for palliative measures.

PROGNOSIS AND RESULTS

The postoperative course was studied so far as possible, and the results in the colloid varieties of carcinoma compared with those of other varieties. According to MacCarty, data from which a prognosis may be made are largely compiled from statistics based on the average length of life from the time the physician or surgeon sees the patient. At best it is based on impressions and certain personal opinions, since there are so many variables and unknown factors in the problem. In general, one considers size of growth, cellular character of growth, age of the host, duration of the lesion, relation of growth to nutrition, emaciation in relation to food intake, proximity of growth to vital structures, lymphatic involvement (regional and distant) distant organic metastasis, multiplicity of the lesions, character of previous treatment, and the morale of the patient. The influence of these factors is purely relative and general.

MacCarty (8) further states that microscopically there are four important factors bearing on the prognosis: lymphocytic infiltration, fibrosis, hyalinization, and cellular differentiation. He found in an analysis of

200 cases that lymphatic involvement decreases the chances of postoperative longevity. The younger the host the shorter the life expectancy after gastric resections, regardless of lymphatic involvement. Differentiation increases the chances of postoperative longevity. In cases of gastric carcinoma without lymphatic involvement or extensive lymphatic infiltration, the greatest average length of postoperative life occurs. Differentiation and lymphatic infiltration combined greatly increases the average postoperative life expectancy. The size of the regional lymph nodes bore no apparent relation to the size of the primary lesion in the stomach.

All of the specimens from the colloid carcinomata were studied grossly as well as microscopically and anything that might have a bearing on the prognosis was carefully checked against the clinical course (Figs. 1 to 7).

The immediate postoperative mortality was about the same as in other types of gastric carcinoma. It was found that in cases in which there was lymphatic involvement postoperative life was shorter.

Specimens showing colloid on the serosa were compared to those in which there was none, and it was found that the colloid, regardless of lymphatic involvement, had increased postoperative life expectancy. Colloid material is apparently a sign of partial differentiation. It appears to destroy the cell or to have that tendency, thus lowering the chances of its being so large a factor in recurrence.

The size and depth of the lesion does not appear to be of prognostic import. The presence of the signet-ring type of cell did not seem to influence results. According to Parham, its presence in the cæcum usually means shorter postoperative life.

The prognosis in cases of young patients showing colloid changes was not good. It was much better in those in which no such changes were noted. As a rule the younger the patient the shorter the life expectancy following operation.

The percentage of patients whose postoperative life was 3 and 5 years averaged about the same as in the other types of gastric carcinoma, but the chance of living longer than 5 years was found to be less in cases in which specimens showed colloid changes. From this it appears that the colloid type of carcinoma although it may grow more slowly is more prone to late recurrence. There is not the tendency to fibrous tissue encapsulation in this type of tumor as is often found in other types.

A noticeable and almost constant feature in this series was the manner in which the patients responded to different types of treatment. Those who were operated on, and later died, improved markedly until recurrent symptoms appeared; after this the end came rapidly. Patients on whom palliative resection was performed had a similar postoperative course in most instances. Most of them who were sent home because of inoperable growths did not experience the symptom-free period.

According to Balfour, an important phase of the indications for resection is seen in the increasing frequency of the palliative resection, which has a great advantage over gastroenterostomy in that the growth is removed, obstruction is permanently relieved, and the patient is assured of several months of comfortable existence.

The present combination of earlier diagnosis and better pre-operative and postoperative management, is making for higher operability rate, lessened immediate postoperative mortality, and better remote results.

The years covered in this study were divided into two periods of approximately 6 years each and the results of treatment in the first 3 years of each period compared. It was found that the number of patients with colloid carcinoma living 3 years or more was definitely increased and the number with other types of carcinoma markedly increased during the latter 6-year period. A study was made of the first and second periods in order to learn if there is a tendency for the lesions to be smaller as methods of diagnosis improve and patients perhaps are coming to physicians earlier. The results were convincing that during the last 6 years of the series the average size of the lesions was definitely smaller.

There is every reason to believe that cases of gastric carcinoma in which operation was

performed in the latter years in the series and those in which operation will be performed in the future, will show results superior to the foregoing when enough time has elapsed for a comparison to be made.

SUMMARY

1. Colloid carcinoma occurred in about 5 per cent of gastric carcinomata. The percentage of patients living 3 and 5 years after operation is about the same as in these non-colloid types of carcinoma. The incidence of late recurrence is greater in the colloid variety.

2. If there is involvement of the lymph nodes, as a rule postoperative life expectancy is decreased.

3. Colloid on the serosa appears to increase the chances of postoperative longevity.

4. There is little tendency to fibrous-tissue encapsulation in colloid carcinoma.

5. The postoperative mortality rate is about the same as in non-colloid types of carcinoma. Postoperative life expectancy is less in young patients.

6. Colloid changes may be noted in the earliest stages of the carcinomatous process.

7. Exploratory operation and microscopic examination is the only sure way to make a definite diagnosis.

8. Resection of the growth usually gives a long symptom-free period.

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SOME EXPERIENCES AND REFLECTIONS ON ONE THOUSAND LAPAROTOMIES FOR MYOMA OF THE UTERUS[1]

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THE history of the operations for fibroids is not yet one hundred years old; in fact, if the early tottering attempts were omitted and only the methodically and carefully prepared and executed operations were considered, scarcely a generation has elapsed since the first operation. But what has not been accomplished during this time! As recently as 1872, Gaillard Thomas called the operation for myoma "truly a formidable one"; today it is performed at every hospital with the same confidence and the same prospect of a favorable result as is any other abdominal operation.

Many pages have been written by Americans on the subject: Washington Atlee had the great satisfaction of seeing the first successful result after operation for myoma; Kimball, of Lowell, performed the first operation on a correct diagnosis. I should also mention the names of Emmet, Stimson, and Kelly. We are right in saying of them as well as of all other pioneers who have preceded us: In what position would we be if they had not existed?

It is not my desire at this time to state that the technique of operation has been perfected, nor do I wish to infer that my figures or my results should be regarded as especially noteworthy. I know very well that others have at their disposal more material and have secured just as good or better results. I would call attention, however, to that which still remains to be done. The advantages of the different methods of operation are not yet definitely settled, the primary results as well as the secondary might be further improved, and radiology prompts us to reconsider the indications for operation. I also believe that a large number of cases from a given source offers better information for the discussion of certain points than would a series of cases collected from many different sources, which would mean that different indications for operation are accepted and different techniques followed. The amount of material is becoming so large that we hope eventually the factor of chance will be insignificant and that certain definite conclusions will be reached. Time permits me to touch upon only a few principal questions.

In one thousand of two thousand twelve cases of myomata observed during a given period, operation was done, that is in about 48 per cent. As is well known, the percentage operated upon varies considerably with different gynecologists. Olshausen, for example, operated upon 16.1 per cent of his cases; Hofmeier, 60.7 per cent; and Engström, about 100 per cent. This difference in percentages is based upon the fact that some operators regard the tumors and the operation as dangerous while others do not. Engström believed that enucleation was the fundamentally correct method of operation and that it was, therefore, advantageous to operate as early as possible.

But even with one operator the percentage of cases operated upon may vary. I find proofs of this in my own experience; to begin with, operation was done in 52 per cent of the cases; the percentage then dropped to 38.7. This was at the time radiological treatment was beginning to be used. The percentage again became higher and during the past few years it has reached the point of 63.9. As I mentioned previously, the total percentage is therefore 48, i.e., operation is considered indicated in about half of the cases of myoma. Until the value of the X-ray in the treatment of myoma is definitely established, it will be impossible to say whether this figure is exact, and even then there will always be differences of opinion among different surgeons.

The indications for operation are clearly shown in Table I. In this table as well as in all the subsequent ones, the absolute numbers can be made to indicate the percentages also, if in each instance a decimal point is placed in front of the last figure.

[1] Presented before the Clinical Congress of American College of Surgeons, Detroit, October 4-7, 1927.

TABLE I.—INDICATIONS FOR OPERATION

Hæmorrhage	494
Pains	159
Growth	119
Mechanical obstacle	82
Size of tumor	16
Gangrene or infection	11
Profuse discharge	12
Cystic degeneration	16
Torsion	4
Suspected malignancy	16
Simultaneous adnexal affection	40
Faulty diagnosis	31
	1,000

It should be stated in regard to Table I that these figures are not the same as those which would be obtained if compiled from examination of the tumors after removal; for example, examination of slides showed that cystic degeneration was present three times oftener than was suspected before operation.

I will now take up the methods of operation which have been used (Table II).

TABLE II.—METHODS OF OPERATION

	Cases
Supravaginal amputation	799
Total extirpation	117
Enucleation	49
Extirpation of pedunculated myoma	35
	1,000

I will not discuss the last group as the method of operation is familiar to all. However, the relative value of the other groups is by no means as yet determined. That from a technical point of view supravaginal amputation is more easily performed than is total extirpation, can hardly be disputed. Besides being more easily performed it can also be done more quickly, which means that not only is it not necessary to keep the patient anæsthetized so long and to use so large an amount of anæsthetic, but of still greater importance the tissues in the pelvis are injured less.

Is this reasoning correct, a difference in the results can be expected. The adherents to the principle of total extirpation look upon such a difference as unimportant and lay stress upon the fact that the results after total extirpation are improved each year so that the two methods are now on an equal footing.

Doederlein gives a death rate of 5 per cent as an average for total extirpation and emphasizes the fact that this is a great improvement over the early death rate of about 9 per cent. This opinion may also be accepted but it seems to me to be just as indisputable that the death rate after supravaginal amputation is less in later years. My experience points in the same direction. The death rate after supravaginal amputation in my series of 799 cases is 2 per cent; after total extirpation in 117 cases, 6.9 per cent. It should also be remembered that total extirpation has been resorted to in more serious cases, such as for tumors of the cervix and malignant tumors, and the results therefore are not quite comparable with those for supravaginal amputation. If total extirpation had been used in the cases in which supravaginal amputation is now done, it might be that there would be more similarity in results. At the present time, however, I cannot help but feel that the immediate safety of the patient is greater after supravaginal amputation than after total extirpation.

The question, however, is not completely answered by the primary results, for we must consider the patient's subsequent state of health. An examination of my cases gives the following information: Of 74 patients upon whom total extirpation had been done, 69—93.2 per cent—were in good health, while 5—6.8 per cent—had some trouble. Of 486 patients upon whom supravaginal amputation had been done, there were 91.3 per cent without trouble and 8.7 per cent with trouble of some kind. The difference is slight and can be explained by the fact that exudation and hæmatomata, which are sometimes observed after supravaginal amputation, do not arise very easily after total extirpation, which provides better drainage. This advantage, however, is counterbalanced by a certain unpleasant dryness in the vagina and introitus which does not appear after supravaginal amputation, after which the discharge of mucus from the cervix is kept up. The figures I have quoted do not seem clearly to lend favor either to one or the other method.

In the presence of both a malignant tumor and a myoma, it is evident that total extirpation is the operation of choice. Herbert Spencer is an energetic champion of total

extirpation as a standard operation in such cases. He reports his own cases as well as those of others in which the presence of the two conditions was overlooked or discovered too late.

It seems to me that this very question, with which future research workers have to deal is at once the most important and the most problematic to solve. I do not enter here upon the question as to whether the myoma itself degenerates and becomes malignant or whether the two forms of tumor develop simultaneously with or without any etiological connection. The questions I would emphasize are: How often does the condition occur and is it possible to diagnose the presence of the two conditions before operation?

Since 1905 all myomata removed at operation have been examined histologically at the pathological institution through the courtesy of my colleagues Forssman and Sjövall. It is true that it has not been possible to make examinations systematically in the sense that all large tumors have been studied in serial section, but we have endeavored to examine especially carefully those which appeared suspicious to the trained pathological eye. If a few cases have escaped attention the final figures may be a little lower than they would have been if all cases had been examined. A tabulation of the findings from the examination of the myomata removed during a period of 20 years at one and the same place is shown in Table III. Curiously enough our figures coincide with those of Kelly, who in one thousand operations for myoma found both myoma and cancer twenty-eight times. In the cases enumerated in Table III, a diagnosis of malignant tumor has been histologically confirmed by competent pathologists. Cases in which a tumor was suspected on clinical examination but in which diagnosis was not microscopically confirmed are not included.

It should be added that at operation for some other condition and at postmortem examination, myoma as well as malignant tumor was found in 21 cases: 1 with sarcoma, 1 with adenosarcoma, 14 with cancer of the uterus; 4 with cancer of the ovary, and 1 with cancer of the vagina. As these cases do not belong to the one thousand in which operation has been done, I wish only to mention them. My material should therefore indicate a frequency of 3 per cent for the significant complication. The figures from other places vary between no per cent (Pfannenstiel) and 10 per cent (Warnekros). This probably is not dependent upon mere chance, but on the difficulty of discovering the presence, for example, of a sarcoma or a highly cellular myoma. However this may be, the combination appears in a certain number of cases, and thus the question arises: Is is possible for us to diagnose the condition before operation?

TABLE III.—CASES OPERATED UPON DURING TWENTY YEARS

	Cases
Myoma plus sarcoma	18
Myoma plus cancer of cervix	2
Myoma plus cancer of uterus	5
	25
To these may be added:	
Myoma plus cancer of tubes	1
Myoma plus cancer of ovaries	3
Total	29

I regret to say that, for my own part, I must give a reserved answer. Just as simple as the diagnosis may be in some cases, just so impossible does it seem in others. Curettement, which might otherwise reveal the secret, meets technical and other difficulties in a uterine cavity which has become distorted by the myoma. Should this difficulty not be present and it were possible thoroughly to curette the cavity, not much relief is obtained as regards the sarcoma of the uterine wall.

The difficulties mentioned with regard to the diagnosis are further illustrated by the fact that in 19 of 29 cases, the malignancy was not even suspected, far less diagnosed. In one of the cases, in doing a supravaginal amputation, the operator cut across a sarcoma which had infiltrated the cervix. I wish to emphasize again the great task which still remains to be solved through the study of the myoma probem.

It seems obvious to me that the choice between supravaginal amputation and total extirpation is dependent upon factors which cannot yet be definitely decided. Not until we have learned to diagnose before operation the simultaneous presence of a malignant

tumor and a myoma can we without hesitation do total extirpation as the treatment of choice in these cases. Possibly the use of supravaginal amputation in the future might be limited to the advantage of total extirpation. It may be added that I have not once observed carcinoma in the portio vaginalis after supravaginal amputation.

The conclusion I have reached with regard to the choice of method in operating is this: If in a patient before, during, or after the menopause, a uterine tumor begins to change, to increase in size rapidly, to produce more abundant hæmorrhage, and to be painful, and if the patient is losing flesh, then malignancy ought to be suspected and total extirpation should be done. As a matter of course, the degeneration may be of another kind, but even then the tumor ought to be removed and total extirpation is safer.

Much has been written and said about the value of enucleation in the treatment of myoma, so I will not repeat here all the arguments for and against it. Suffice to say that besides Martin, other eminent gynecologists consider enucleation fundamentally superior. I need mention only the name of Otto Engström. In my own experience, enucleation has been done 49 times without a fatality. There is thus nothing to be said as to the immediate results. The fundamental reasons for this method of treatment are not focused on immediate results but on the question of a later pregnancy, and recurrence; the strength of the operation is to be found in the fact that pregnancy is possible; its weakness is in the risk of recurrence. As to the possibility of pregnancy after enucleation, Engström states its frequency as 6.5 per cent, Winter on the contrary only 3.2 per cent. In my experience, pregnancy followed enucleation n 6 cases; that is, in about 12 per cent—a figure of importance.

In contrast to this group of patients in whom enucleation has been done and thus the full function of the generative organs preserved, is another group that is not fully satisfied, namely those who have had a recurrence of hæmorrhage or of a tumor. Martin claims that this condition is found in 6 to 7 per cent; Engström and Winter in 6 per cent. In my experience the number is higher —18 per cent. Such figures must of course be regarded as proof that the operation has been deficient in some respects and it must be so understood by the patient. Some patients have been obliged to be operated upon again, and this was true in not less than 5 of my 9 cases. Add to this the fact that of the patients operated upon radically, a considerably larger number, 91 to 93 per cent, are definitely in good health without any trouble, while after enucleation several (in my series of cases, about 32 per cent) complain of discomfort such as pain, menstrual disturbances, and the like. It cannot be denied that this is often a drawback to an operation which is otherwise ideal, in the sense that it removes the diseased part without sacrificing any of the healthy tissue.

TABLE IV.—PRIMARY MORTALITY

	Cases
Pulmonary embolism	13
Infection	4
Pneumonia	1
Endocarditis and pleurisy	1
Endocarditis and encephalitis	1
Urine infiltration (lesion of the bladder first discovered at autopsy)	1
Chronic anæmia	1
Miliary tuberculosis	1
Suffocation (aspiration of vomited content of stomach)	1

In spite of the great respect that I have for the memory of Engström, having been his pupil, and in spite of the admiration I have for his contribution to this matter, I do not, however, consider it possible to imitate him in giving enucleation the place of honor as the principal method. Even without such aspirations, it has a place of honor among the operations for the treatment of myoma and cannot be replaced. In the course of time my own viewpoint has become such that I perform enucleation only if the patient is young, for instance, below 35 years of age, and if an approaching marriage or other circumstance renders the preservation of the power of conception specially desirable. I consider it a duty to the patient to explain the situation to her before the operation, that she may decide a question that so closely affects her future.

I next arrive at the question which interests all and especially the operator who is respon-

sible for the operation; that is the question of primary mortality. In my material the primary mortality has been 2.4 per cent. I am quite aware that many in America are able to show better results. The causes of death are shown in Table IV.

Table IV is self-explanatory so I will mention only the first two items. With regard to embolism, the mortality amounts to 1.3 per cent, a figure corresponding to that stated in other series. It would seem, unfortunately, that the causes of embolism would remain unknown for some length of time and that we would not be able to protect the patient against this danger. I have tried to promote the circulation of the blood and to counteract the want of exercise by means of massage performed by a competent person and started the day after operation. However, I dare not yet express an opinion as to its use, as, during this time, there have been five cases of embolism in a series of 300 operations for myoma. The four cases of infection deserve mention as it would seem that with our up-to-date aseptic technique, an infection ought scarcely to be met with.

An operative infection with a fatal termination has fortunately occurred only once. A real operative infection appeared in one case in which I have not the case history. The patient succumbed to paralytic ileus. In another patient the cause of death was an infection from a postoperative retroperitoneal hæmatoma. In a third case there was present a gangrenous myoma which resulted in an intraperitoneal abscess which was drained at operation. Autopsy showed septicæmia and also that by means of drainage the spreading of the infection into the peritoneum had been prevented. And, finally, the fourth case is of interest because the infection had originated from an intra-uterine radium treatment later followed by operation with the result mentioned.

It may naturally be asked if any of these deaths might not have been avoided. As far as the cases with pulmonary embolism are concerned, such an expectation is unfortunately not yet justified. As regards infection, an operative infection may be so far avoided that it cannot exercise any great influence on the result. On the contrary it is not possible to avoid an infection that arises from a tumor already infected or gangrenous and operation has to be done as a last resort. It must also be remembered that a university clinic in Sweden must receive cases which have been turned away from other clinics. Should we in such cases consider our statistics first or should we bear in mind the welfare of our patient?

As to the other causes of death, two at least could have been avoided: the injury to the bladder which occurred in one of the earlier cases and the aspiration of vomitus. In the latter instance the patient vomited while alone and aspirated the contents. It should also be acknowledged that however careful we are or consider ourselves to be and however much the results are being improved with age and experience, the day will surely never come when the results in a series of operations becomes such that improvement could not be made. To balance the risks correctly before interference, is skill, to say the least. *Es irrt der Mensch so lang er strebt.*

In a number of cases there have been other complications of consequence and yet the outcome has been favorable. We would mention thrombosis in 9 cases; pulmonary embolism in 4; parametritis, or possible hæmatoma, in 5; and parotitis in 2; as well as lesions in the ureters in 2. I will not dwell on these.

Other complications such as concurrent adnexal disease which have been diagnosed before operation are of great importance. Their nature is shown in Table V.

TABLE V.

	Cases
Ovarian or parovarian tumor	42
Malignant ovarian tumor	3
Hydrosalpinx	3
Pyosalpinx	8
Tuberculosis	10
Extra-uterine gravidity	2
Tubal cancer	1
	69

The interesting point as far as treatment is concerned is that, in more than 39 cases, the complication was not diagnosed before operation and in most of these cases, perhaps

30, there were certainly ovarian tumors present which were not discovered until operation. This has no other influence on the operation than that the adnexa are also removed. But the lack of knowledge as to the presence of adnexal disease may influence the decision of the surgeon as to the method of treatment to use—whether operation or the X-ray.

Among other peculiarities in the cases of myoma operated upon, I will mention only that in the last series of 300 cases of myoma, myoma of the cervix appeared 7 times; a retroperitoneal myoma, 9 times; and a degenerated cyst, 10 times.

I will not enter at this time into the question of pregnancy in the presence of a myoma, as these cases in many respects and especially from an obstetrical point of view should be treated separately. I take the liberty only of contradicting the opinion that seems to prevail in certain publications in recent years that a myoma present in a pregnant woman should be removed, for the reason that the growth may possibly give rise to complications during parturition. "The morrow bringeth counsel"; a myoma without any symptoms neither need nor should be operated upon during pregnancy.

There is still another matter of importance which I wish to mention. What will the result be if in removing a myoma both the ovaries are removed or one or both are left?

The question has been much debated and has had many different answers. It surely does not seem just to remove the ovaries unnecessarily in a young woman who is many years from the natural menopause. Again, in another who has reached this period or is near it, the risks seem less if the removal of the glands, from technical or other reasons, be advantageous. What are the real facts in the case?

I regret that I did not earlier pay the attention to this question that it no doubt deserves. I am not able therefore to make an exact statement except in reference to the last 300 cases. Of these 300 cases, in 77 both ovaries were removed and I have definite information regarding them. It is remarkable to note that in 64 of these cases, 84.4 per cent, there was no trouble and 4 patients were less than 40 years of age. The 13 patients who had trouble that might be connected with the castration were all between 40 and 52 years of age. On the other hand, I have reports on 64 patients operated upon in whom one or both ovaries had been left and in whom there was no reason to expect endocrine disturbances. Of these, 9—14 per cent—had symptoms of menopause. The ages in this group ranged from 31 to 43 years.

From these experiences, it seems to me that two facts might be mentioned. First, it is not easy to judge whether the symptoms really depend upon something else—a neurosis, a suggestion or whatever it may be—to which the operation has given rise, or whether they might be the result of the removal of the uterus; for why should such symptoms be observed in patients whose ovaries have been left? Second, in a large number of patients, the ovaries have been removed and no such symptoms have appeared, and many times the patients are less than 40 years of age. I have, therefore, in the course of time come to the conclusion that the ovaries are not to be removed even in patients more than 40 years of age if menstruation still persists at the time of operation. On the other hand, there need be no scruples against the removal of the ovaries if the adnexa show such changes that the chances of the patient would be improved by ovariotomy.

I have touched in this paper only lightly upon a question which is still of such grave importance that it deserves thorough study, that is the question of the relative indications for treatment by operation and by X-ray. The reason for this is that I have not yet had sufficient experience in this direction. I believe that one ought to wait until he has a large series of cases in which the X-rays have been used and that such patients should be watched for many years before a definite statement is made as to which method of treatment is indicated—operative or radiological—in a given case. I shall restrict myself to the statement that I have tried the intra-uterine application of radium to myoma in 103 cases but I have abandoned its use entirely. In the cases so treated a diminution in the size of the tumor was noted in 60

cases; a favorable influence on hæmorrhage in 87 cases; but in 15 cases infection set in. For some reason or other 12 patients had to be operated upon later and 3 patients who were free from cancer before treatment were found to have it later. In late years I have cautiously and feelingly used the X-ray treatment, but the number is only 51 so far. The result of such treatment has been that immediately or after renewed treatment hæmorrhage has ceased in 70—6 per cent—and that in 9.8 per cent operation has later had to be done. We should bear in mind in this connection the possibility of malignancy or other degeneration being overlooked through faulty diagnosis.

Time will show to what extent X-ray treatment is adapted to give the patient the same security as the operative treatment without subjecting her to the added risks. Should this be possible, X-ray treatment without any hesitation may replace the operative treatment; should it not be possible, I believe that an operation which removes the diseased part and leaves the healthy is more to be desired than a method of treatment which by way of the ovaries influences the production of hæmorrhages but leaves the tumor.

SUPPURATIVE DISEASES OF THE CHEST[1]

By GEORGE P. MULLER, M.D., F.A.C.S., Philadelphia

SUPPURATION within the chest would seem to be a comparatively simple matter to discuss and yet the uncertainty regarding certain phases, and the technical difficulties involved in many of the procedures, make it complex. As I have no new methods to offer and the recent literature is so full of productive work, I am forced to present to you the opinions of one who does general surgery with perhaps more than the average experience in chest surgery. Speaking as one surgeon to another we can exchange ideas regarding our own methods, taken as they usually are from the more highly specialized studies of those engaged in a particular problem.

The great groups are empyema, lung abscess, bronchiectasis, and mediastinitis. We must omit any preliminary discussion regarding the anatomy or the physiology of respiration, however tempting the latter may seem. Every surgeon who undertakes chest surgery should be familiar with the studies of Graham, and the earlier writings of Garre, Sauerbruch, Willy Meyer, Lilienthal, Hedblom, to mention only a few which stand foremost in my mind. The section on pulmonary suppuration in the monograph of Garre and Quincke published in 1912 can be the starting point, and upon this base, little by little, one can build a knowledge of the shifts and changes which have had to occur before chest surgery attained its present sound position.

Empyema is the most important suppuration in the chest in the experience of most surgeons. As seen in ordinary civil practice, it is practically always the result of a pneumonia. At this time we will not discuss whether it results from lymphatic or contact infection of the small serous effusion present in nearly all cases, or whether it is due to the rupture of small abscesses on the periphery of the lung.

There are three matters of paramount importance. The first is to recognize the probability of empyema in every case of pneumonia that does not get well promptly. Delayed resolution is often another name for empyema. Prompt diagnosis is essential to low mortality and freedom from the chronic cavity. The second point is the need to distinguish between the synpneumonic and metapneumonic effusion. Operation should be delayed if possible until the pneumonia has resolved. There are statistics showing that the mortality approaches 50 per cent in a group of cases operated on during the first week after onset of the pneumonia, whereas it was 10 per cent between the fifth and eighth week. The latter

[1] Read before the Clinical Congress of the American College of Surgeons, Detroit, October 4–7, 1927.

time is probably too long but certainly we should wait until the signs and symptoms indicate that the pus collection predominates and the pneumonitis has cleared.

The third point to be emphasized is the need for discrimination and individualization in the technical aspects. Ether anæsthesia probably can be safely used in most cases but there is no need for it and certainly it is contra-indicated in those who are "sick." Local anæsthesia, and sometimes a little gas, for adults, is quite sufficient. Since the days of Hewitt (1876) and again since the War, we have had periodic advocacy of drainage through a catheter as a standard method. I have practiced inter-rib puncture in 54.1 per cent of my cases. But the experience of most surgeons is that open drainage is required, sooner or later, in most cases. In our series it was 72.7 per cent, 50 per cent of the children, and 94 per cent of the adults requiring a rib resection after the preliminary intercostal tube drainage.

The point is this, we must not create an open pneumothorax while a pneumonia exists. If, by reason of a streptococcus empyema, as seen in the camps during the War, or if because of great toxæmia or pressure in the pneumococcic empyema we must operate during the synpneumonic stage, it is imperative to do nothing more than relieve the pressure by the simplest means. But if the case has advanced to the metapneumonic phase, with its walled-off abscess and thick pus, a rib resection with adequate drainage is indicated. Let me caution you not to delay too long if there is need for better drainage after a few weeks of intercostal tube drainage. The temperature reactions and the X-ray picture furnish the guides. As I am trying to deal with principles only, no discussion will be added regarding irrigation, complications, or after-treatment. Early, adequate, dependent drainage is essential to success; all else merely helps a little. Chronic empyema with cavity is an end-result usually of delay and inadequate treatment. Before undertaking the serious and difficult operations for its cure we should study the writings of Keller and Hedblom.

Abscess of the lung is a more serious affection than empyema, not only from the standpoint of treatment but also because of the greater difficulties in diagnosis. Some discussion of the etiological factors is essential. At least 30 per cent are postoperative in origin and about one-half of these follow the operation of tonsillectomy. It is difficult to evaluate the exact mechanism concerned in the non-operated group. Lord (1925) believes that "lobar pneumonia appears to be of little moment in the etiology and an origin in bronchopneumonia is uncertain." But some of the cases are so clear-cut that it is probable that a small but definite group do follow lobar pneumonia. A larger group arise from the bronchopneumonias because of the greater damage to the lung. Most likely the lung, in certain patients, develops a low local area of resistance and secondary invasion of chance pyogenic organisms or of the various cocci, vibrios, spirochætæ, and fusiform bacilli found in tonsillar crypts and around the teeth determines the breaking down of tissue. Smith (1927) has produced abscess by the injection of these organisms into the trachea, and he noted that it is probable that abscess goes through a preliminary pneumonic stage before breaking down. Perhaps some of the apparent pneumonias described by patients with abscess are examples of this primary pneumonitis. Mullin (1926) offers some suggestive proof that paranasal sinus infection is capable of reaching the lung by way of the lymphatics. Foreign bodies of vegetal or other origin constitute a second group of suppurative diseases of the lung but this only simulates abscess and is more of a bronchiectasis, because removal of the foreign body is almost invariably followed, as shown by Jackson, by complete recovery.

More interesting is the group which follows operations. Septic emboli from any focus discharging into the general circulation may cause acute abscess. When multiple, the outlook is bad, particularly as the patient is generally septic. Operations on the upper air passages, particularly tonsillectomy, as a cause for abscess, have been a source of controversy now for several years. The great number of tonsil operations performed offers the probable explanation. The field is septic and the parts in continued motion. Fetterolf and Fox (1923) brought this fact to our attention and since

then the work of Cutler and his associates have pretty well established the fact that most lung abscesses after tonsillectomy result from septic emboli, just as do those after operations on other parts of the body. Smith, however, believes that his experiments prove the opposite and that aspiration is the potent factor. We must not exaggerate the frequency of abscess after tonsillectomy because an operator may do thousands of tonsil excisions before he has one abscess of the lung as a complication. Weil (1925) makes the interesting suggestion that when the patient never seems to convalesce, has fever, constant cough, and chest pain, then aspiration may be the cause, whereas when normal recovery has occurred and suddenly about 10 days later the chest symptoms develop, embolus is the factor.

The diagnosis of lung abscess is not particularly difficult if we pay strict attention to the history and character of the sputum in the case of a patient with cough, fever, and chest pain. When suspicious we can get clear-cut evidence from the roentgenograms, if these are well taken, because the casual roentgenologist rarely gets good pictures of the chest. Needling should never be used as a diagnostic aid because of the danger of producing pyothorax. The obscure cases are those small collections about the hilus and the interlobar collections which may be called loculated empyemata by some or abscess by others. If an expert bronchoscopist is available, an additional aid to diagnosis is furnished. Nor need we be concerned as to the existence of abscess or gangrene. Most of the abscesses, multilocular as they are, have areas of gangrene in the walls and the massive gangrenes result from large infarction with death of the lung parenchyma before cavitation occurs. The symptoms of massive gangrene are so acute that there is hardly time for treatment before death occurs. Bronchiectasis is associated with most chronic abscesses but only becomes an entity when widespread throughout one or both lungs.

The treatment of lung abscess requires perfect localization, a nicety of judgment, and careful technique. The internist, roentgenologist, surgeon, and, if possible, the bronchoscopist should work together for the best interest of the patient. The roentgenologist determines by the plain film and, after lipiodol injections, the exact location of the cavity, whether or not it drains and the extent of bronchiectasis. The bronchoscopist inspects the bronchial tree particularly for foreign body or tumor, notes the condition of the mucosa, and whether pus is flowing from the lobes. He injects the lipiodol to outline the cavities and to diagnose the bronchiectasis; he also decides particularly in the case of lower lobe and hilus collections as to whether or not he can improve or possibly cure the patient by frequent bronchoscopic aspirations. The internist endeavors to improve the general condition of the patient, advises diets of high caloric value, administers arsphenamine for the fetor, or gives creosote, arranges for blood transfusions in the very anæmic, and tries particularly by postural methods to effect drainage of the cavity.

We are all agreed that the desirable thing for the patient is to have the abscess drain into the bronchus. It is most unwise to operate during the more acute phases of the disease when the area of pneumonitis is extensive and the bronchioles are filled with pus. For both reasons non-operative methods always should be given a fair and extended trial but the method should be thorough and persistent. Perhaps 30 per cent will get well and stay well under rest, postural drainage, and bronchoscopic aspiration. With Graham (1926), I am somewhat skeptical of the value of bronchoscopic aspiration alone, but Jackson and Tucker have had some very interesting cures in our hospital. Such treatment presupposes the probability of drainage, and the X-ray and bronchoscopic examination determines this point. If drainage is not accomplished, if the abscess is well up in the upper lobe or at the periphery, then operation should be performed as soon as the patient's general condition has been improved. Sharp localization in the X-ray picture shows the subsidence of the pneumonitis. Even if drainage is accomplished, the persistence of the cavity is an indication for operation. Furthermore, I am of the opinion that with any degree of bronchiectasis, external drainage of the cavity is advisable. I do not mean bronchiectasis of the lung but bronchiectasis of the lobe. Do not delay too

long and do not let your patient get away from treatment until cure is effected.

When operation is finally decided on, many interesting technical points open up for discussion. In simple abscess I have found it best to resect a portion of one or two ribs over the area of abscess without opening the pleura. Some gauze saturated with mercurochrome solution is then packed against the parietal pleura and the skin flap temporarily closed. Four or five days later the wound is re-opened, and it will be found that the lung is sufficiently adherent in practically every case so that the cavity can be entered with the cautery. The opening should be large and the cavity carefully drained and cleaned with the suction aspirator. If it is small, I use only a large soft rubber tube but if large some mercurochrome gauze is lightly packed in for two days. All of these procedures should be done strictly under local anæsthesia. Shortly, the cavity should be inspected for additional pockets and these and bronchiectatic openings can be opened up or treated with a small cautery point. This is the reason for making the external opening sufficiently large. I always keep the drainage tube in place for many months, particularly if there is bronchiectasis, otherwise "flare-ups" will occur requiring re-opening of the incision. In some cases a limited thoracoplasty may be necessary. I do not believe that phrenic nerve section or crushing is worth while. No mention was made of artificial pneumothorax because I do not think it is a wise procedure. The exposure of the abscess is easy enough if it is perfectly localized except in the case of the upper and middle lobes high up and posterior. But the scapula can be "winged" by dividing the rhomboid muscle or the lower part of the scapula can be resected. In one female patient I was obliged to work well under the breast to expose a high anterior collection. I have entirely given up the older method of suturing the lung to the parietal pleura.

Bronchiectasis is the third suppuration in the chest. Usually some parenchymal inflammation, such as an influenzal bronchopneumonia, induces a fibrosis and this twists and obstructs the bronchi, causing their dilation. When these dilated bronchi become the seat of a suppurative bronchitis, purulent sputum results which may be slight, periodic, or continuous, and excessively offensive. We must always remember the possibility of a vegetal or other foreign body as an etiological factor. In some cases an infarction from mildly septic emboli may produce a suppurative pneumonitis with invasion of the walls of the bronchial tubes and, as Singer puts it, a sort of carbuncular ulceration occurs. These small pockets then appear to the roentgenologist as bronchiectatic areas. Areas may be masked by shadows of the heart or diaphragm, the fibrosis may be confusing or the pleura thick, thus making X-ray diagnosis difficult. The injection of lipiodol has made such cases more apparent and has greatly enhanced our ability to diagnose bronchiectasis and determine its extent in a lobe, a lung or both lungs.

Surgical treatment of bronchiectasis has not yet attained a perfectly secure basis. It is conceded that the disease must be unilateral. Pneumothorax is not satisfactory, intrathoracic lobectomy is too hazardous. Graham (1923) has offered a great improvement in his operation of cautery excision. A flap of the chest wall is turned up and 3 or 4 ribs removed for distances of about 4 inches. The exposed ends of the ribs are packed with bone wax to minimize the danger of osteomyelitis, and the adjacent intercostal nerves injected with alcohol to destroy sensation in the wound. The pleura is then opened with a small incision and, if firm adhesions are not present, the cut is closed and the wound packed for a few days. Either at the first or second stage a large soldering iron heated to a red heat is pushed into the lung and the suppurating bronchiectatic area cauterized. It is essential to so cauterize as to obtain multiple drainage openings by exposing a large cross-section of the bronchial tree. In about 3 weeks, cauterization is repeated. Hæmorrhage is controlled by packing, and this is efficient because the blood pressure in the pulmonary artery is usually only about 20 to 25 millimeters of mercury. Graham suggests that if ligation of a branch of the pulmonary artery to a lobe in the human being should prove to be as easy and simple an operation as Sauerbruch claims it to be, then the danger of hæmorrhage could practically be eliminated in the operation of

cautery pneumectomy by first performing a ligation of the corresponding branch of the pulmonary artery. If ligation of the corresponding pulmonary vein should also be performed, then the danger of cerebral embolism would also be excluded.

Following the lead of Friedrich, Sauerbruch, and others, Hedblom (1923) has advocated a graded extrapleural thoracoplasty for diffuse unilateral bronchiectasis. The whole lengths of the lower ribs, usually from the third to the eleventh, inclusive, are resected in multiple stages, the number of stages depending on the condition of the patient. While the diseased bronchi are not eradicated by the operation, it has proved effective to the extent of markedly relieving cough and sputum in all cases, approximating a cure in many. This operation is the only hope for patients in whom the disease involves more than one lobe of the lung. When the bronchiectasis involves the lower or perhaps the upper lobe alone it seemed feasible to amputate that lobe but in the hands of the average surgeon this operation has had a mortality approaching 100 per cent. Recently, Whittemore (1927) has advocated delivery of the affected lobe outside the pleural cavity with anchorage by suture. In about 10 days the lobe becomes necrotic, sloughs off, and leaves a clean granulating stump, deep in the pleural cavity with a bronchial fistula in it. The operation is similar to that proposed by Lockwood (1922) for abscess.

We must choose between these operations depending on the pathology. In diffuse unilateral bronchiectasis without abscess, graded thoracoplasty seems obligatory. In lobar bronchiectasis, and this is usually complicated by abscess, extrathoracic excision of the lobe may be considered if there are no adhesions. In the presence of adhesions and multiple abscesses, the cautery method of Graham seems best. The objections to thoracoplasty, as leaving infected bronchial tissue, are met by the statement that secondary cautery operation is feasible. Hæmorrhage following cauterization is to be feared but usually is controllable with gauze packing. The occurrence of cerebral embolus is not confined to the cautery operation. I have lost two patients after simple drainage from this cause, when recovery from the abscess had practically resulted.

Suppurative mediastinitis is the last of the group under consideration which I will discuss. The sources of mediastinal suppuration may be traced to the adjacent bones, the lymph nodes, as an extension from the neck especially after operations in the lower part which are followed by suppuration, or as part of the suppuration of streptococcic empyema. I have had deaths from this cause after an operation for intrathoracic goiter, after œsophagotomy, and after block dissection of the neck for cancer. The symptoms are grouped under the head of pain, sepsis, and pressure on structures in the mediastinum. When recognized the abscess should be opened and drained. This is easy of performance in the case of the anterior mediastinum but in the case of posterior mediastinitis one must choose between cervical mediastinotomy and the dorsal approach, preferably by the method of Heidenhain. The latter certainly gives better drainage but is harder to perform.

Even from this rapid review, one can become enthusiastic about thoracic surgery. The problems seem more complicated than those met in the abdomen but this only makes the subject more fascinating. Rather recently a new field is opening by reason of the development of a method of thoracoplasty for the cure of certain cases of pulmonary tuberculosis, but the treatment of tumors of the lung still await solution. It will not be long before the surgery of the thorax attains the same sound position that is occupied by the surgery of the abdomen and cranial cavity, and this will lead to greater refinement in technique, lower mortality, and better end-results.

DISCUSSION

Dr. C. A. Hedblom, Chicago: Dr. Muller's presentation seems to me remarkably comprehensive, concise, and detailed, considering that his theme embraces the major portion of the whole field of thoracic surgery. With most of Dr. Muller's postulates I am in entire accord. To one or two of them I should like to add what emphasis I may. To some particulars in which I disagree I shall devote most of the limited time at my disposal.

In his discussion on empyema, Dr. Muller very properly emphasizes the importance of early diag-

nosis and prompt drainage, the avoidance of pneumothorax in the pneumonic stage, and individualization in the choice of technical procedures. I should like to stress the value of the so-called "closed method" of treatment of empyema. It represents the practical application of the one important new principle of treatment developed during the last two decades, namely, the avoidance of the open pneumothorax incident to the time-honored rib resection, and drainage in any patient with a low respiratory capacity from any cause. A low respiratory capacity obtains in the presence of a pneumonia, particularly of the hæmolytic streptococcus type before the lung has become adherent, in the infant and the aged, irrespective of the lung infection, and in the acute postoperative pneumonia with empyema. The early withdrawal of infected fluid even in the seropurulent stage by the closed method followed by antiseptic solution irrigation relieves mechanical embarrassment to respiration from the fluid, restores the mediastinum and the lung to their normal relationship and so improves respiration, lessens toxic absorption, and by the use of the antiseptic fluid actively combats the infection.

The fundamental principle in the treatment of any empyema is to empty the cavity of pus and keep it empty all the time until the empyema cavity is obliterated. The closed method properly carried out fulfills this requirement better than any other method; imperfectly carried out, as it will be if the patient is left at home to the care of the family, it is entirely unsatisfactory except to tide over a crisis. With hospital care with trained attendants, the closed method is not only safest and most effective but also constitutes the *de luxe* treatment of empyema.

In his discussion of pulmonary abscess, Dr. Muller touched on several controversial points. With regard to the etiology of post-tonsillectomy abscess he made the statement that most surgeons consider them embolic in origin. I am under the impression that most surgeons especially interested in this condition believe most of them to be of the inhalation type. The protagonists of the embolic theory base their contention chiefly on their failure to obtain pulmonary abscess in dogs following instillation of infected material into the trachea. Other workers, among them Smith, Crowe, and Joannides working with me at the Research and Educational Hospital of the University of Illinois have obtained abscesses in a large number of dogs and other animals by injecting infected material into the tracheæ. The practical importance of this discussion is that as long as the weight of evidence indicates that a large proportion of post-tonsillectomy pulmonary abscess and postoperative abscesses are due to inhalation infection, every possible precaution against such operative inhalation infection is obligatory.

Lipiodol contrast media roentgenography is proving of considerable value in the diagnosis of atypical cases of pulmonary abscess, particularly such as produce a shadow difficult to differentiate from a pleuritis. The lipiodol fails to enter the terminal bronchi in the pneumonic portion of the lung surrounding an abscess. Secondary abscesses imperfectly drained may also be demonstrated by injecting the oil through the bronchus draining into the thoracotomy incision. Secondary bronchiectasis may be demonstrated by similar means.

The choice of treatment of pulmonary abscess it seems to me rests on three criteria: (1) the clinical progress of the case, (2) the location of the abscess, and (3) the pathological anatomy of the abscess. If the patient is progressively improving, expectant treatment and postural drainage is indicated indefinitely. If the symptoms are marked and at a standstill, more active treatment is desirable after at most 8 or 10 weeks. If the progress is steadily downward, active treatment—particularly drainage—may save the patient's life. Some of the very best results in my experience have been early, in acute cases of this type. According to my observation the proportion of cases that get well spontaneously is much nearer 10 than 30 per cent. The safest and most logical treatment of a central hilus abscess and perhaps pneumothorax, is postural drainage and bronchoscopic lavage. The only rational treatment of a large peripheral abscess draining imperfectly through a long narrow sinus into a bronchus is thoracotomy drainage.

Chronic abscesses may require cautery treatment to heal bronchial fistulæ and thoracoplasty to obliterate stiffened cavities. Cautery extirpation is necessary for the honeycomb type of abscess. Cases of multiple abscess involving a whole lung are usually beyond surgical relief.

Lipiodol contrast media roentgenography is to the diagnosis of bronchiectasis what the bismuth meal or enema is to the diagnosis of gastro-intestinal lesions or sodium iodide to those of kidney pelvis. Pulmonary compression by pneumothorax, phrenic nerve resection, and thoracoplasty, following early accurate diagnosis, I feel sure will greatly improve our results in its treatment. One result of compression, of fundamental importance to the treatment of bronchiectasis, and one not sufficiently well recognized, is a pulmonary fibrosis which is largely responsible for the favorable results obtained from thoracoplasty.

THE RELATIONSHIP OF CARCINOMA AND CALLOUS GASTRIC ULCER

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WHEN Cruveilhier first distinguished gastric ulcer from carcinoma, he mentioned their occasional coexistence in the same stomach. For 50 years they were thought to have little or no connection with each other. Then Zenker made the suggestion that gastric carcinoma might arise regularly from a preceding ulcer and in 1883 his pupil Hauser (47) published a careful pathological report illustrating this method of development. Just before the publication of this study of postmortem specimens, however, had begun the brilliant advances in gastric surgery which were soon to vitalize the question of a relationship between carcinoma and chronic gastric ulcer. Billroth reported the first successful resection of the pylorus for carcinoma, and Woelfler introduced gastro-enterostomy in the same year, 1881. Gradually surgeons learned that a number of cases following gastro-enterostomy for an indurated gastric ulcer died later of carcinoma of the stomach (Rodman, 70, and Mayo, 59). Furthermore, in specimens of resected stomachs, on microscopic examination, carcinoma was found in many cases where the history and operative findings had led the surgeon to make the diagnosis of benign chronic ulcer. This frequent association of the clinical syndrome or the gross picture of chronic gastric ulcer with histological cancer stimulated several surgeons and some pathologists to urge the frequency of "carcinoma ex ulcere."

This idea was for a time received favorably. It is true that a Lyons group headed by Tripier and Duplant described a variety of gastric carcinoma characterized by extremely slow growth, chronic ulceration, and clinical symptoms mimicking chronic gastric ulcer (80 and 31). This type they named "ulcus rodens gastrique." They felt that the lesions showing both carcinoma and ulcer were ulcerated primary cancers, rather than the carcinomatous degeneration of a benign ulcer. But the demonstration of a chronic gastric ulcer in the walls of which carcinoma cells were found was frequently advanced as adequate proof of "carcinoma ex ulcere." And some went so far as to assume that gastric cancer usually arose upon an ulcer basis.

However, by a critical pathological study of the benign and carcinomatous ulcers, the following points were gradually established: (1) Localized infiltrating carcinomata often become ulcerated. (2) Such lesions have the typical gross appearance of a chronic gastric ulcer. (3) In certain areas all of the malignant cells may disappear. (4) Usually when cancer cells are found in ulcers they are distributed in different parts of the latter which is evidence in favor of primary ulcerated cancer, rather than a carcinoma developing in one part of a chronic ulcer. (5) The scar tissue base of the chronic ulcer entirely replaces the muscle layer while the carcinoma cells in ulcer-like lesions usually infiltrate between some preserved muscle bundles. (6) In order to demonstrate the probable development of carcinoma from an ulcer it is necessary to find such a scar tissue base not infiltrated with carcinoma (Stewart, 75, and Spilsbury, 74). Applying such criteria for a pre-existent ulcer to a study of the specimens showing carcinoma, Aschoff (4) and Stromeyer (76) concluded that there was evidence of the malignant degeneration of chronic gastric ulcer only in a small percentage. Dible, in a very critical pathological study, has recently confirmed this opinion (26). From such investigations we may conclude that carcinoma of the stomach does not usually arise from a preceding chronic ulcer. If the application of these pathological studies stopped here they would have served to critically readjust an unsupported hypothesis. But from them the apparently obvious corollary has been deduced by several that the danger of carcinoma need scarcely be considered in the clinical diagnosis and treatment of chronic gastric ulcer. This point of view was recently expressed

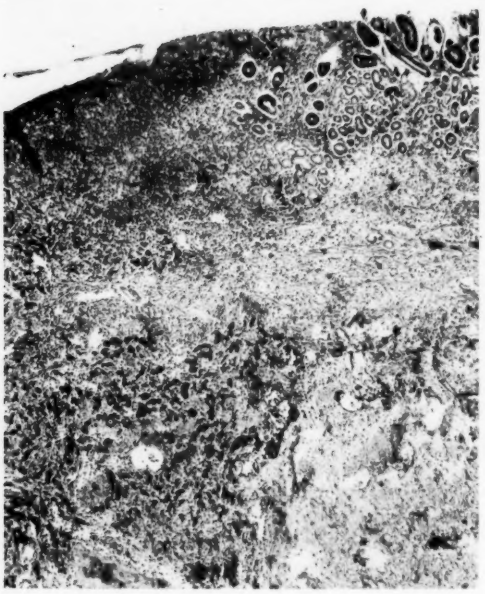

Fig. 1. Case 1. Carcinoma simplex in the base of the ulcer. (×40)

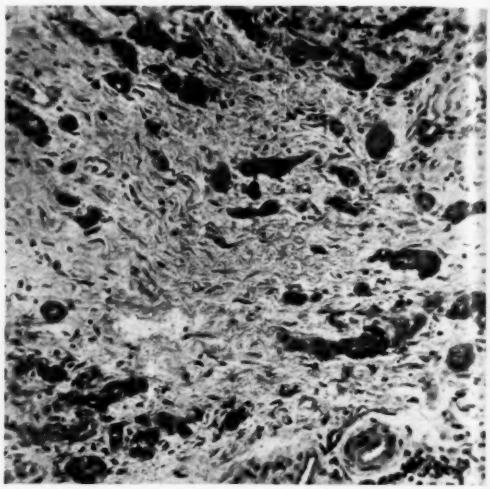

Fig. 2. Case 1. Same section as in Figure 1. (×125)

for example by Morley in the symposium of the British Medical Association on carcinoma of the stomach (62). After quoting Dible's pathological studies, he concludes: "An event of such comparative rarity (the malignant degeneration of chronic gastric ulcer) should not influence us then unduly either in the diagnosis of gastric carcinoma or in the treatment of gastric ulcer." This same sense of security is expressed even more forcefully by the action of many physicians in instituting a protracted dietary treatment in cases that clinically appear to be chronic gastric ulcer.

There have grown up then two diametrically opposed points of view in regard to the relationship of carcinoma to callous ulcer in the stomach. Cabot and Adie have recently summarized this protracted discussion (15). The issues debated have been the occurrence and frequency of the development of gastric carcinoma from gastric ulcer. This controversy over the pathological mechanism has tended to obscure rather than to emphasize certain facts of fundamental clinical importance. In the treatment of every case diagnosed as chronic gastric ulcer, the question that must first be answered is: "What danger is there that this condition may now or later be malignant?"

Two patients who were in the Peter Bent Brigham Hospital at the same time illustrate the clinical importance of this problem. Similar examples could as easily be taken from the experience of all physicians and surgeons who follow up the end-results on their cases diagnosed as chronic gastric ulcer.

CASE 1. J. M. S., P.B.B.H., Surg. No. 20006, male, aged 58, admitted October, 31, 1923, with the complaint of vomiting. The present illness began 5 years previously with epigastric distress after meals which had increased in severity. There was relief by food and soda and the discomfort was accentuated by dietary indiscretion. Two years previously periodic vomiting had begun occurring every 3 or 4 weeks at first but in the last year coming about every 10 days. The vomitus never contained fresh or old blood. For 9 weeks he had been on a milk diet which had relieved the epigastric distress but had not prevented the periodic vomiting. Appetite had been excellent and he had had acute hunger on the milk diet. He had had no tarry stool except on one occasion immediately after the extraction of all his remaining teeth. He had always had a tendency to constipation which had been greatly accentuated in the last year. He had lost only 10 to 15 pounds even with the reduced diet and vomiting and had continued to work throughout.

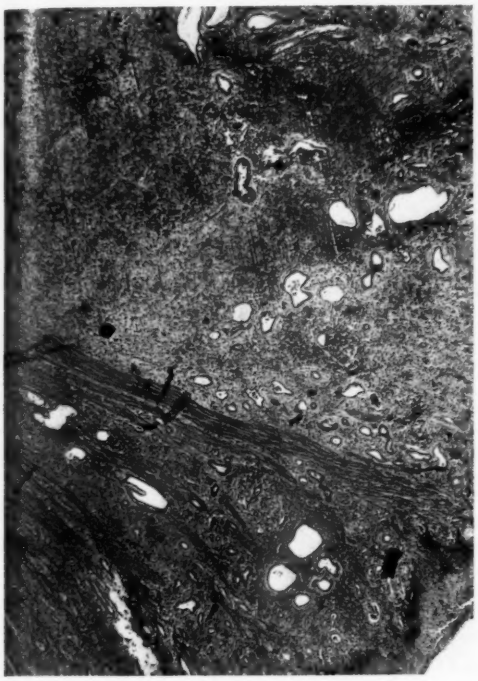

Fig. 3. Case 2. Adenocarcinoma in callous ulcer base. Note infiltration of carcinoma acini between muscle bundles. (×40)

The past history is irrelevant. Physical examination demonstrated moderate loss of weight. The heart had a systolic murmur well transmitted. The abdomen was scaphoid, soft, and contained no masses. The liver was not enlarged.

Leucocytes, 17,000; hæmoglobin, 90 per cent. Urine, negative. On account of the vomiting, gastric analysis was not done, but the vomitus showed an excess of free hydrochloric acid and a negative benzidene test.

X-ray examination revealed a dilated, atonic stomach of smooth outline everywhere except at the pylorus where there was a concentric narrowing involving the sphincter. There was irregular and reverse peristalsis in the stomach and nearly complete 6 hour retention. The interpretation was "obstructive lesion at the pylorus which may be either carcinoma or ulcer."

The consensus of opinion before operation was that the lesion was a cicatrizing gastric ulcer with pyloric stenosis, though the possibility that it might prove to be a carcinoma could not be excluded. Dr. Cheever's note of November 4 states: "The picture is a characteristic one of benign pyloric stenosis due to cicatrizing ulcer, and I think that probably a Finney pyloroplasty will be the best treatment."

Fig. 4. Case 3. X-ray of the stomach. Niche on lesser curvature.

At operation, November 5, 1923 (by Drs. Cheever and Scott), before the Boston Surgical Society, a saddle ulcer of the lesser curvature was found. It was surrounded by extensive induration which reached nearly to the pylorus (5 centimeters) but did not occlude this orifice. The induration suggested malignancy and partial gastrectomy (Billroth II) was performed. Also a small nodule 3 millimeters in diameter, on the anterior surface of the duodenum 2 inches past the pylorus was removed. Frozen sections were made particularly on account of this anomalous nodule on the duodenum. The pathologist reported on the frozen section that the gastric ulcer was benign but that the nodule from the duodenum was an adenocarcinoma. However, when the fixed sections were obtained, the pathological report was revised. The nodule of the duodenum was an aberrant pancreatic nodule and the gastric ulcer showed definite carcinomatous infiltration in the base (Figs. 1 and 2). No metastases were found in the glands.

The patient had an uneventful convalescence and was discharged November 22, 1923. He had gained 20 pounds, and was feeling perfectly well in June, 1925. Since then it has been impossible to obtain any information concerning him.

CASE 2. H. E. L., P.B.B.H., Surg. No. 20179, female, aged 65 years, admitted November 23, 1923, on account of epigastric distress, anorexia, and vomiting. For the past 30 years she had had periodic attacks of epigastric distress after meals, relieved by soda, by induced vomiting, and sometimes by food. No hæmatemesis. The attacks were more frequent in the last 2 years. For the past 6 weeks anorexia and vomiting have been marked. Vomitus contained food taken 24 to 48 hours previously. The past history is irrelevant.

Physical examination showed no cachexia and only slight loss of weight. The abdomen contained no masses, but there was peristalsis seen in the epigastrium.

X-ray studies showed an atonic dilated stomach with vigorous, irregular peristaltic waves. The outline was smooth except in the antrum where the

Fig. 5. Case 3. Adenocarcinoma localized to one area of the ulcer. (×15)

outline of both curvatures was irregular. There was a 50 per cent 6 hour residue. The X-ray findings were interpreted as suggesting a carcinoma of the antrum with partial obstruction.

Gastric analysis after test-meal: free hydrochloric acid, 70 per cent; total acidity, 79 per cent. Urine, negative. Blood: hæmoglobin, 106 per cent; erythrocytes, 5,848,000; leucocytes, 7,600; polymorphonuclears, 53 per cent; lymphocytes, 41 per cent; mononuclears, 6 per cent.

On account of a characteristic ulcer history of 30 years' duration with hyperacidity, and absence of cachexia, the pre-operative diagnosis was chronic gastric ulcer although the X-ray findings rather favored carcinoma but were not incompatible with ulcer.

At operation, November 24, 1923, (by Dr. Holman), a callous ulcer on the lesser curvature close to and causing stenosis of the pylorus was found. It was thought that this was a benign ulcer, the operative note stating, "However, the amount of induration present and the adhesions on the superior surface prompted the operator to perform a pylorectomy instead of a Finney pyloroplasty." (A Pólya-Balfour partial gastrectomy was done).

The gross specimen showed a penetrating ulcer on the lesser curvature near the pylorus with a crater 1.4 centimeters in diameter surrounded by considerable induration. The gross appearance suggested a carcinomatous ulcer. Sections from the edge showed only chronic inflammatory reaction. Sections from the base of the ulcer showed carcinoma cells infiltrating into the muscular layer and permeating between the muscle bundles (Fig. 3).

The patient's convalescence was uncomplicated and she was discharged December 14, 1923. On November 24, 1926, she was symptom-free and gastro-intestinal X-ray examination showed no evidence of recurrence. In response to a letter in March, 1927, she responded that she had had no indigestion and that she was well and strong.

These two cases from their clinical story and laparotomy findings suggested callous gastric ulcers which had caused pyloric obstruction. At operation one of the lesions seemed to the operator to be benign, the other one was thought probably malignant, but on frozen section a pathological report of benign chronic gastric ulcer was given to the operator in the latter case. Fixed sections in both instances showed infiltration of carcinoma in the scar tissue base. Consequently, on the basis of the pathological evidence these cases are not to be classified as *carcinoma ex ulcere*. They probably are examples of a slow-growing primary scirrhous carcinoma of the stomach, in which ulceration proceeds almost coextensively with the proliferative process. It seems almost certain that the second case had some preceding condition other than carcinoma to produce ulcer-like symptoms for 30 years as there was nothing found at operation outside of the stomach to account for such symptoms. Possibly this lesion was a chronic gastritis as suggested by Versé (81) and Mathieu (58). These 2 cases would not even be included in the group studied pathologically by Dible because in each case some phase either in the clinical picture, the findings at operation, or the gross appearance of the lesion suggested to the surgeon or the pathologist the possibility of carcinoma. The significant facts, clinically, are that such cases as these quoted are frequent occurrences, that they either begin upon or probably more often only mimic an indurated ulcer, but that these two conditions cannot be certainly differentiated by any known clinical method. On account of the ulcer-like symptoms such carcinomata are usually diagnosed as ulcers.

Such cases proving pathologically to be localized, ulcerated, infiltrating carcinoma but diagnosed clinically as ulcer, are frequent. Instances in which there is histological evidence of a pre-existent chronic ulcer are very

much rarer. The following case seems to belong in this latter small group.

CASE 3. C. H. B., S. M. H., No. 4368, male, aged 66, admitted December 11, 1926, with the complaint of pain in the stomach. The present illness began 12 years ago with epigastric pain coming on 3 hours after meals, and always relieved by food and soda. With periods of remission, it has bothered him since onset. In the last 2 months the pain has been exactly as previously except that it has come about 2 hours after meals. Seldom has he vomited and never had hæmatemesis or melena. He has had no loss in weight, Wassermann reaction has been strongly positive, and he has had energetic antiluetic treatment for over a year. X-ray showed a penetrating ulcer niche on the lesser curvature with vigorous peristalsis elsewhere (Fig. 4). No 6 hour residue.

Blood: hæmoglobin, 80 per cent; urine, negative; stool: formed, brown, microscopically no red blood cells; guaiac test, negative. Gastric analysis: fasting; free hydrochloric acid, 18 per cent; total acidity, 46 per cent. After Ewald meal, 45 minutes: free hydrochloric acid, 18 per cent; total acidity, 43 per cent; 75 minutes: free hydrochloric acid, 52 per cent; total, 76 per cent.

The pre-operative diagnosis was callous gastric ulcer; there was no positive indication of malignancy.

At operation on December 18, 1926 (by Dr. Scott), a penetrating ulcer with a crater about 1.5 centimeters in diameter and 1 centimeter deep was found. There was nothing to suggest malignancy, the base of the ulcer was adherent to the pancreas. Partial gastrectomy (Pólya-Moynihan) was performed and the area where the ulcer was attached to the pancreas was cauterized. Convalescence was uncomplicated and the patient was discharged January 15, 1927. He has gained 15 pounds and has remained symptom-free to the present (May, 1927).

The gross specimen showed a typical callous ulcer with no suggestion of malignancy. The edges were firm but not abnormally indurated. The proximal edge was overhanging and the distal one was terraced.

On section the base of the ulcer was formed of scar tissue which entirely replaced the musculature and showed merely the usual evidence of chronic inflammation (see characteristics of chronic ulcer, Fig. 7). In one area, however, there was a definite small zone of adenocarcinoma which spread out from the hyperplastic mucous membrane at the edge of the ulcer (Figs. 5 and 6). This did not infiltrate the scar tissue base at a distance. In other sections carcinoma was not found. After the discovery of this one area of definite carcinoma, 8 blocks were cut from various areas of the uncut half of the ulcer. In none of them was there any trace of carcinoma (Fig. 7). It was felt, therefore that the specimen fulfilled the exacting pathological criteria of a carcinoma arising presumably upon a preexistent ulcer.

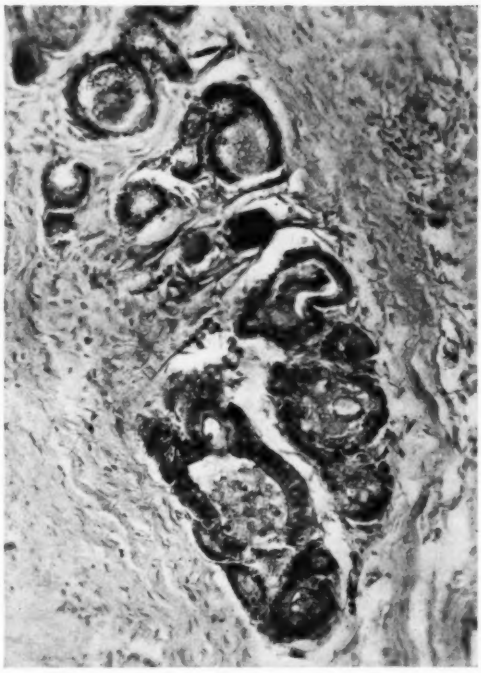

Fig. 6. Higher magnification of section outlined in Figure 5, showing a cluster of carcinoma acini. (×250)

Although we feel that this is an illustration of *carcinoma ex ulcere*, its clinical significance is the same as if carcinoma cells had appeared in multiple places in the ulcer. Its chief interest lies in the fact that it appeared clinically to be an uncomplicated case of chronic gastric ulcer, both before and at operation, yet it proved to be carcinomatous.

The history was a typical ulcer story of 12 years' duration. The gross appearance of the ulcer gave no suggestion of malignancy. In fact, it appeared so evidently benign that no photograph of the gross specimen was made. Without the histological findings or if the first sections had been cut only from the half of the ulcer which by chance was cut later after finding the isolated carcinoma focus, no one would have thought it anything but a typical callous gastric ulcer which had penetrated sufficiently deeply to become adherent to the pancreas.

INCIDENCE OF CARCINOMA IN CALLOUS ULCER

The clinical importance, then, of the relationship of carcinoma and chronic gastric ulcer is not dependent upon the development of the former from the latter but lies in the impossibility of the certain clinical differentiation of the two conditions. This difficulty is not reflected in the hospital records. When malignancy has been found in the resected specimen, carcinoma of the stomach appears as the final diagnosis, and the diagnostic problem is buried in an analysis of cases under the heading of "carcinoma of the stomach with a positive ulcer history." Before operation, though, the case *is* a chronic gastric ulcer and when the microscope does not reveal the mistake, it often remains on the records as only a chronic ulcer, the patient dying elsewhere of carcinoma. It is extremely difficult to disentangle from a statistical presentation of cases the data that will present in a true light this clinical dilemma of the differentiation of benign callous ulcer and ulcer-carcinoma.

The reports based upon cases only diagnosed clinically and not operated upon have limited value on account of (1) the difficulty in being certain that an ulcer is present, (2) the confusion of duodenal and gastric ulcers and, (3) the difficulty in determining the final outcome. I have found no report of a series of cases with convincing X-ray evidence of gastric ulcer, followed over a sufficiently long period of time (at least 5 years) from which to derive data as to the proportion of chronic gastric ulcer cases that eventually prove to be carcinomatous.

Nielson's study of the end-results of medically treated cases, clinically ulcers, deserves mention although X-ray evidence is largely lacking (65). His selection of cases included only those in which there was good evidence of organic disease, though a large proportion of them must have been duodenal rather than gastric ulcers. Of 221, 11 died of gastric carcinoma and 1 other had carcinoma in the part of the stomach resected later. Thus of the total series, 5.4 per cent were subsequently proven to have carcinoma of the stomach. This would probably correspond to about 20 per cent of the true gastric lesions, as duodenal ulcers are at least 4 times as numerous as gastric in the clinics. All but 2 of the cases developing carcinoma had had symptoms for less than 6 years (15 per cent of the 66 cases of chronic ulcer with such a limited duration of symptoms).

This study of medically treated ulcers, although unsatisfactory for statistical analysis on account of the lack of X-ray evidence, still definitely demonstrates again the danger of carcinoma proving to be present in cases clinically diagnosed as benign ulcer. Joslin (49) also reports a 6 per cent mortality from carcinoma in the combined series of gastric and duodenal ulcer.

Sippy (71) emphasizes the necessity of watching for the evidence of a carcinoma as a possible complication in all cases of gastric ulcer but he gives no statistical figures. Smithies (73) emphasizes that many authors decrying the danger of carcinoma in gastric ulcer, are dealing chiefly with duodenal rather than with gastric ulcers; and he adds that he always feels nervous about the outcome of a true gastric ulcer until a laparotomy has determined the location and nature of the lesion. This deficiency in regard to exact reports of the late results of medically treated gastric ulcers in part is due to the fact the X-ray localization has only been of great help in the last 15 years and in part is because internists have come to realize increasingly that the medical treatment of true callous gastric ulcer is unsatisfactory and dangerous (Alvarez, 1).

Although more exact statistical reports of the evidence of carcinoma in medically treated chronic gastric ulcer are lacking, its danger is amply attested by the large number of lesions, diagnosed as benign ulcer after careful clinical study, that prove upon operation to be carcinomatous. In the examination of resected callous ulcers, clinically benign, carcinoma was found in the following per cent: Moynihan (64), 18 per cent; Payr (68), 26 per cent; Kuettner (50), 30 per cent; Finsterer (38), 21 per cent. von Haberer (43) describes the diagnostic difficulty at operation after exposing the lesion, as follows: "Five per cent mistakes, how many doubts!" Morley,

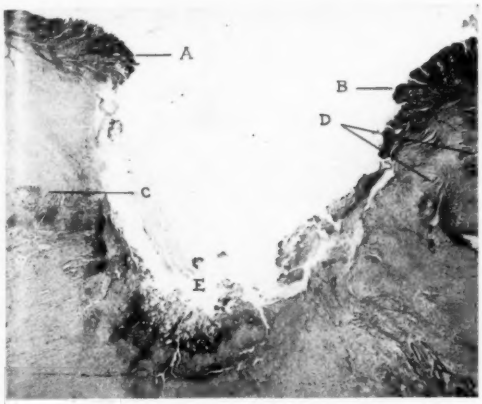

Fig. 7. Case 3. Typical chronic indurated ulcer. Note overhanging edge, A; somewhat terraced edge, B; muscle completely interrupted, C and D; and inflammatory scar tissue base, E. (×15)

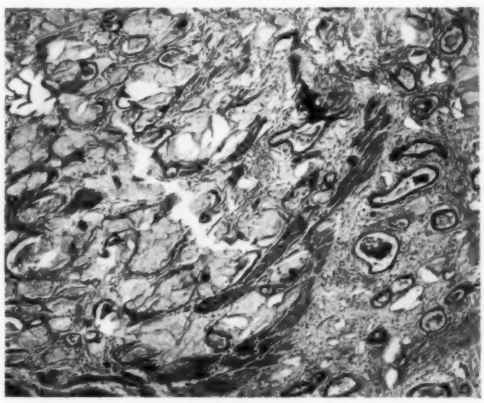

Fig. 8. Case 4. Photomicrograph of a colloid carcinoma from the base of a callous ulcer. Note the presence of acini infiltrating between the muscle bundles. (×125)

although willing to dismiss the danger of carcinoma from consideration in the treatment of gastric ulcer, received a pathological diagnosis of definite carcinoma in 10 per cent of 50 specimens considered by him even after they had been removed, to be simple gastric ulcers (61). Aschoff, who is extensively quoted as an opponent of the frequency of "carcinoma ex ulcere," expressed surprise at the large number of resected specimens resembling in form the ordinary round ulcer, but proving microscopically to be carcinomatous (4). Masson (56) reported that in 1400 resected ulcers, clinically benign, 18 per cent were found to be carcinomatous on histological examination. From these statistics of many clinics it would seem to be a conservative estimate that in 10 to 20 per cent of the chronic gastric ulcers there is a carcinoma actually present, whether it has arisen from a chronic ulcer or has been from the first a primary carcinoma with secondary ulceration.

Another line of evidence corroborates this significant proportion of indurated ulcers that appear benign but prove malignant. An actuarial study of the life-expectancy of patients operated on for duodenal and gastric ulcer at the Mayo Clinic was made (6 and 8). The death rate in the succeeding years was not above the normal expectancy after operations for duodenal ulcer but was over 3 times this figure after operations for gastric ulcer (17 per cent mortality in 3½ years). The most important factor causing this was the development of gastric cancer. In 1280 patients followed for an average of 3.6 years after operation for gastric ulcer, there were 195 deaths, at least 75 of which were determined as due to carcinoma, and many more in which the data was inconclusive probably died of this cause. Upon a careful re-examination of the specimens, classified as ulcer at operation, from patients dying subsequently of gastric carcinoma, it was found that half of them showed evidences of malignancy that had been overlooked (Balfour, 8). Also, Anschuetz (2) reports death from gastric carcinoma in 8 to 11 per cent of cases of calloused ulcer followed 2 years or more; and in 334 gastro-enterostomies for ulcer of the stomach and duodenum von Eiselsberg (33) found that in 41 remote deaths 13 were known to have been due to carcinoma of the stomach, a probable incidence of 15 to 20 per cent in the true gastric ulcers. It is quite impossible certainly to differentiate benign calloused ulcer from carcinoma at operation, sometimes after examination of the resected specimen, and occasionally even histological study of the ulcer does not settle the question. Eggleston (32), Wilensky and Thalhimer (85), Mayo (60).

DISCUSSION OF STATISTICAL RESULTS

There are many reports based upon more or less carefully analyzed clinical material in which the conclusion is reached that carcinoma is an infrequent finding in gastric ulcer. Opposed to this view is the opinion from many surgical clinics that carcinoma is a very frequent finding in callous gastric ulcer. This apparent contradiction is in some instances of each opinion due merely to careless diagnosis, either clinical or pathological. But even in the most carefully studied cases the same difference of opinion is recorded. This is more apparent than real, however. In the medical series are usually included those cases that have symptoms suggestive of ulcer, many of short duration and most of which are not verified by demonstration of the lesion. The surgical group is made up almost entirely now of indurated ulcers of long standing. By operation the existence and the character of the lesion have been demonstrated. A careful pathological study of such resected specimens has entirely changed our opinions concerning the life cycle and the degenerative and regenerative processes of chronic gastric ulcers. Crohn, Weiskopf, and Aschner (20). The apparently opposing views are consequently dependent largely upon the types of cases studied, and often from the data included in reports of non-operated cases it is extremely difficult to be certain what varieties of ulcer the author is reporting. It is generally accepted now that acute or subacute gastric erosions frequently heal and remain healed under proper medical treatment, that consequently such lesions should not be operated upon except for their complications and that they are not precursors of carcinoma. Crohn, Weiskopf, and Aschner (21). Such acute ulcer syndromes are much more common than is the chronic indurated ulcer. Moynihan (64). On account of their inclusion as well as that of other lesions that are not chronic gastric ulcers (especially chronic duodenal ulcer) in the group of medically treated patients, the danger of carcinoma in true callous ulcers is sometimes hidden in the reporting of such lesions. Especially is this true if both gastric and duodenal ulcers are included in one study under the designation "peptic ulcer," a term which of itself signifies a lack of sufficiently exact data for accurate localization. For properly evaluating the dangers and the results of treatment in the much less frequent chronic gastric ulcers these should always be presented in a separate group, distinct from acute gastric ulcers and from duodenal ulcers. In order to clarify the diagnosis and the type of lesion in future analyses of cases, it would be of great assistance if gastric ulcers were classified somewhat as Cushing (22) has grouped brain tumors.

CLASSIFICATION

For use both in the hospital records and in the reporting of cases of gastric ulcers I propose the following classification:

I. Gastric ulcer—suspect.
II. Gastric ulcer, unverified (carcinoma suspect).
III. Gastric ulcer, verified.
IV. Carcinomatous gastric ulcer, verified.

Under each of the first 3 headings designate whether acute (non-indurated) or chronic (indurated).

Gastric ulcer, suspect, includes all cases in which a tentative diagnosis of gastric ulcer is made. In these, localizing evidence to distinguish between gastric and duodenal lesions is often lacking and so these groups may be classed together as peptic ulcer suspect if so desired. It is only in this group, however, that this non-localizing term, peptic, should be permitted. Many in this group prove later to have no ulcer at all but to have ulcer-mimicking symptoms from pylorospasm, gallbladder disease, etc. The peptic ulcer, suspect, cases should not be included in a consideration of gastric or duodenal ulcer except as regards the differential diagnosis. Moynihan (63) has also stressed the great importance of basing the study of gastric ulcer upon those cases proved by X-ray or operation to have an ulcer.

Chronic gastric ulcer, unverified, includes those cases that have definite signs of localization in the stomach as well as ulcer symptoms sufficient to establish the diagnosis clinically. Specifically the clinical picture should be supported by X-ray or operative evidence compatible with indurated gastric

ulcer. These lesions are always carcinoma suspects.

Chronic gastric ulcer, verified, includes only those cases having histological evidence of an indurated ulcer. If carcinoma is found in the ulcer it places the lesion in the class of proven gastric carcinoma, but in order to have these ulcer-like malignant lesions available for study it would be advisable to name them, "Carcinomatous gastric ulcer" and cross file them both under carcinoma and under chronic gastric ulcer.

It is now at once evident that most of the gastric erosions, the acute gastric ulcers, must necessarily fall in the group of gastric ulcer suspects as usually there is not sufficient localizing data to justify the diagnosis of gastric ulcer unverified. Very rarely can they be classed as acute gastric ulcer verified since most of them disappear under medical treatment. In the earlier days of gastric surgery, operation was frequently performed for such ulcers without finding any definite lesion.

If the cases are reported under such a classification it at once forms a basis for comparison and analysis such as does not now exist in many of the reports of gastric ulcer. I believe it will quickly dispel the appearance of disagreement in regard to the danger of carcinoma occurring in cases diagnosed clinically as callous ulcer of the stomach.

Including only those cases having had ulcer symptoms for several months and showing X-ray evidence of a gastric lesion compatible with ulcer, 10 to 20 per cent of such chronic gastric ulcers, unverified, will prove to be carcinomatous.

TREATMENT AND RESULTS

As a direct and specific corollary of this fact, all cases of chronic gastric ulcer ought to be considered and treated as carcinoma suspects. Nearly all writers agree that a suspicion of malignancy is an urgent indication for radical surgical treatment of a chronic gastric ulcer (Alvarez, 1; Bevan, 10). From the cases and evidence cited above, it seems that the symptoms of chronic gastric ulcer constitute such a suspicion of malignancy and consequently except for positive contra-indications to operation the lesion should promptly be removed (Douglas, 28; Finsterer, 36). Lahey (51) advises the hospitalization and medical treatment of such cases for 2 weeks. At the end of that time he decides upon the basis of relief of symptoms, the absence of occult blood, and decrease in the size of the X-ray niche whether the lesion is benign. If these criteria are not favorably affected he operates. This is a big improvement over the previous method often used, of ignoring the danger of carcinoma or of heeding it only when positive clinical signs of malignancy have developed. When an ulcer shows such a change in symptoms with constant pain, emaciation, and an acidity it usually means the extension of the malignant process so that the chance for surgical cure usually is already gone (Cheever, 18; Cheney, 19; Masson, 56). Even the method advocated by Lahey, however, does not with certainty differentiate malignant from benign lesions in the early stages. A carcinomatous ulcer may for a time show partial healing, great improvement in symptoms, and absence of occult blood (Dieulafoy, 27; Hurst, 48; Eusterman, 34). Consequently, it seems to me to be the safest course to regard all callous gastric ulcers (as defined above) as potential cancers. One of our prominent gastro-enterologists emphasizes this point thus, "If the physician lets him (the patient with chronic gastric ulcer) drift on with medical treatment, he assumes a tremendous responsibility" (Alvarez, 1). If this point of view can be inculcated into both the profession and the laity, the outlook would be greatly improved in this ulcer-mimetic group which constitutes about one-fifth of the gastric carcinomata, and we should have made a stride forward in the percentage of curability in this form of carcinoma. Twenty years ago carcinoma of the stomach was regarded as having practically a hopeless prognosis (Friedenwald, 40). Today there are a number of 15 and 20 year cures so that we are certain that the prognosis is not hopeless (Wegele, 82; Basch, 9), and in cases that can be resected there is a 22 to 31 per cent 5 year freedom of recurrence (Anschuetz, 3; Finsterer, 37; Hartmann, 45). Our immediate hope of improving the results in gastric cancer lies in operation while complete removal of the

malignant process can be carried out (Cheever, 17). There are 2 definite lines of progress toward this end, which have in common the treatment of patients above the age of 35 with gastric complaints, as carcinoma suspects unless the latter can be ruled out (Blackford, 11). In one group are those that in middle life or later without any obvious cause develop some vague gastric symptoms or general asthenia and loss of weight (Goldie, 41; Master, 57). Such cases are to be carefully investigated as possibly having carcinoma of the stomach and if necessary for its exclusion an exploratory laparotomy should be performed (Deaver, 25; Dunham, 30). The other group is that of the indurated gastric ulcers. These cases can never be differentiated clinically as certainly benign (Smithies, 72). X-ray examination does not distinguish between the carcinomatous and the benign gastric ulcer except in the late stage (Carman, 16; Baetjer and Friedenwald, 5). Surely hypo-acidity is no criterion as Hartman (46) has emphasized. Probably it is true as Nielson (65) contends that the greatest number of carcinomatous ulcers are among the group with ulcer symptoms for less than 6 years. That this is no sure criterion, however, is evident from our Cases 2 and 3 and many other examples in the literature. Thomas (78) has also called attention to the relative infrequency of an ulcer producing an hour-glass stomach being malignant. This immunity is only relative, however. A callous gastric ulcer removed at any stage of its clinical course may prove malignant (MacCarty and Broders, 53). MacCarty (55) has pointed out that those over 2.5 centimeters in diameter are usually carcinomatous. This is true but, as Alvarez (1) remarks, even when the crater is small the patient cannot be assured that he has not a carcinoma, and the aim of medical practice should be the diagnosis and eradication of the carcinomatous ulcer before it has reached such a large size. For this purpose, the co-operation of the internist and the surgeon is necessary in diagnosing the potentially carcinomatous lesion from early symptoms, and in educating the laity to this danger. The time to attack the malignant gastric ulcer is in the months or years before signs of malignancy have arisen and while the ulcer symptoms only are present (Finsterer, 35).

The exact prognosis in this group of chronic carcinomatous ulcers cannot be separated satisfactorily in the literature from that of localized carcinoma of the stomach in general. There are available too few cases with correlated clinical and pathological findings, together with the end-result. It is surely clear, however, from examples of such cases reported that the prognosis is dependent upon the extension of the lesion beyond the stomach (Eusterman, 34; MacCarty and Blackford, 52). Even in spite of delays of months or of years many such cases have had "clinical cures" (Peck, 69; Hartmann, 45).

On account of the danger of carcinoma, the operation of choice for callous ulcer in the distal half of the stomach is partial gastrectomy. Balfour (7) has advocated cautery resection. He reports 130 partial gastrectomies with 4 deaths subsequently from carcinoma (3 per cent), and 296 cautery resections with 10 later fatalities from carcinoma (3.3 per cent), each apparently followed by the same risk of carcinoma recurrence. However, as he suggests, the larger ulcers are not satisfactory for treatment by local excision, consequently a greater proportion of the more extensive carcinomatous ulcers are probably included in his resected group. So it seems that these groups are not comparable for statistical purposes. Pauchet (67) reported better results from partial gastrectomy than following cautery excision.

My personal observations, though not sufficiently extensive to be conclusive, have led me to the conviction that partial gastrectomy if technically feasible is far superior to any form of local excision. Two lesions of this type which were thought to be benign chronic ulcers were liberally excised with the cautery. Both recurred, one, 2 years and the other 4 years after operation. Both of these cases seemed favorable. In fact at operation there was nothing to suggest that they were malignant, carcinoma being found only by histological examination. Two other cases, at operation apparently less favorable than the former, have gone after resection, in one case 4 years (Case 2 of this paper) and in the other

6 years without evidence of recurrence. The most important item in the operation is the wide excision of the glands of drainage with the resected portion of the stomach. While in most cases a margin of 4 to 5 centimeters past the indurated tissue is ample to prevent local recurrence in the stomach itself, (Thalhimer and Wilensky, 77) the operation should remove particularly the glands of the lesser curvature (Hartmann, 44). In order to include these, most of the lesser curvature is excised in the resection. For re-establishing the gastro-intestinal canal, Moynihan's modification of the antecolic Pólya operation (64) has given us most satisfactory results. The immediate postoperative recovery is surprisingly smooth and the functional result is excellent. Wheeler (84) also remarks about how little postoperative reaction there is from this procedure. The mortality of such a resection for chronic ulcer is little if any greater than after local excision (Moynihan, 64, 1.6 per cent; Finsterer, 35, 2.3 per cent). If there is extension of obvious carcinoma outside of the stomach requiring formidable accessory procedures such as resection of the colon, the pancreas, or the liver, the operative mortality mounts (Finsterer, 39). Such mortality statistics have no bearing upon the risk of resection for lesions that appear to be chronic ulcer. Partial gastrectomy, then, offers the only chance of cure for the lesion that is obviously malignant at operation and also the best chance of cure with a very low mortality for the callous ulcer in the pyloric half of the stomach.

HISTOLOGICAL TYPES REPRESENTED

All types of carcinoma are found histologically in these callous ulcers. Carcinoma simplex was illustrated in Case 1 and adenocarcinoma by Cases 2 and 3. Colloid carcinoma is less frequently found. In its early stages there is nothing to distinguish it clinically or in the gross from other carcinomatous ulcers. The following case illustrates this variety.

L. G. O., S. M. H., No. 3404, male, aged 43, was admitted to the hospital November 4, 1926, with the complaint of pain in the epigastrium and vomiting. The present illness dated back 2 years when he began to vomit once a day, not accompanied by pain or nausea. After a year, this subsided for several months. For 3 months before admission he had had epigastric pain 2 or 3 hours after eating, relieved by vomiting or alkali. Vomitus had been of a coffee ground variety at times. Loss of 15 pounds had taken place in the last 3 months. Examination revealed some emaciation. Stool showed no occult blood.

Gastric analysis, fasting: free hydrochloric acid, 9 per cent, total acidity, 20 per cent; after Ewald test meal: free hydrochloric acid, 10 per cent; total acidity, 27 per cent. Gastro-intestinal X-ray showed irregularity in the pyloric antrum (lesser curvature) and a 6-hour residue.

The pre-operative diagnosis was gastric ulcer. At operation November 5, 1926 (by Dr. Morton) a large callous ulcer was found on the lesser curvature. Before resection there was no definite proof as to whether the lesion was benign or malignant. Its size (3 centimeters in diameter) and the induration around it suggested on gross inspection that it would prove to be a carcinomatous ulcer. Sections of the lesion showed colloid carcinoma infiltrating deeply into the base of the ulcer (Fig. 8).

Whatever the type of cell, all of these malignant callous ulcers share the characteristic of ulceration nearly co-extensive with the malignant proliferative process. In fact, the typical gross picture of chronic ulcer with an undermined oral edge and a terraced distal margin is frequently found. In the base or the edge of the ulcer, the carcinoma cells may be very abundant or may be found only with difficulty. Thomson and Graham (79) and also Thalheimer and Wilensky (85) have each reported a case in which multiple sections failed to demonstrate any carcinoma but in which the latter was found in the lymph glands. Usually cords of malignant cells invade the base, infiltrating between the muscle bundles. Sometimes, however, the carcinoma is confined to one area with a typical ulcer scar, most of which is uninvaded by the malignant process. This latter is the only type which Dible considers. Clinically it cannot be differentiated from the primary carcinomatous ulcer (Dahl-Iversen, 23, and Duplant, 31) and its prognosis is the same. There is no definite correlation between cell type and prognosis (Brodnitz, 14; von Haberer, 43, and Weil, 83) except that the colloid carcinoma usually spreads throughout the peritoneum and if the stomach is removed before the malignant cells reach the serosa

there is less danger of lymphatic metastasis having already occurred (Deaver, 24, and Duggan, 29). The results of resection of the stomach, however, do not show any great difference in colloid carcinoma from the other types (Parham, 66).

Recently, Broders (12) established a correlation between the degree of malignancy and the histological differentiation of cellular structure of carcinoma of the lip. This principle has been found to apply in certain other malignant tumors (Greenough, 42). Carcinoma of the stomach, also, has been studied from this point of view by MacCarty and Mahle (54) and Broders and MacCarty (13). There is a slightly longer survival in the group showing the greatest cellular differentiations but this correlation is not nearly as important as in carcinoma of the lip and breast.

SUMMARY

Historically there has arisen a controversy over the malignant degeneration of chronic gastric ulcer. This protracted debate concerning the pathological mechanism has detracted attention from the significant clinical fact that there is a type of carcinomatous ulcer which mimics exactly chronic gastric ulcer in its symptomatology and physical and X-ray manifestations.

As Nielson states, the point of view of the surgical pathologist should be that "one can never be too reserved when dealing with the diagnosis of *carcinoma ex ulcere*." However, of far greater importance to the patient, the point of view of the clinician (both the internist and the surgeon) should be, one can never be too certain in the differentiation of chronic gastric ulcer from carcinoma.

As there is no sure way of distinguishing clinically between the benign and malignant callous gastric ulcer, all such ulcers ought to be considered and treated as carcinoma suspects. The doctor who temporizes with chronic gastric ulcer may be robbing that individual patient of cure and is opposing the education of the laity in regard to the early diagnosis and radical treatment of gastric conditions that may be carcinomatous. The hopeful phase of the treatment of gastric cancer is the radical removal of the lesions before the development of the classical signs of malignancy. In a large number of gastric carcinoma cases the lesion is inoperable when symptoms first manifest themselves. These ulcer-carcinomata do not fall into the above group but are characterized by symptoms for months and often years before they are so extensive as to prevent resection.

Pathologically such lesions seem usually to be slowly growing, primary localized carcinomata in which the ulcerative process is nearly co-extensive with the neoplasm. In a small number, however, there is pathological evidence that the carcinoma has developed upon a true chronic ulcer, the classical *carcinoma ex ulcere*. These pathological types cannot be distinguished clinically and often not in the gross specimen.

All types of carcinoma may be found in these malignant callous ulcers. There is not sufficient data upon which to base a differential prognosis separate from other localized gastric carcinomata, or according to the cellular type represented. When resection is feasible, it results in a 25 per cent 5 year freedom from recurrence.

The difference of clinical opinion about the danger of carcinoma in chronic gastric ulcer seems to be due chiefly to the types of cases studied. A classification is suggested which will assist in differentiating similar groups for comparison and in ruling out of consideration the large number with inadequate data for localization.

Limited to those cases presenting ulcer symptoms over a period of months or years with definite X-ray evidence of localization in the stomach, clinically diagnosed chronic gastric ulcer will prove carcinomatous in 10 to 20 per cent.

CONCLUSIONS

1. The controversy concerning the development of carcinoma from chronic gastric ulcer has obscured the significant clinical relationship of these two conditions.

2. It is frequently impossible to differentiate clinically the malignant from the benign callous gastric ulcers in the stage when cure is still possible. It cannot even be done with certainty at operation in many cases.

3. As a corollary to this fact, all callous gastric ulcers are carcinoma suspects and should be treated as such, both before and at operation.

I want to express my appreciation to Dr. Harvey Cushing and Dr. David Cheever for permission to include in this report the cases which I studied at the Peter Bent Brigham Hospital. I am indebted for the photomicrographs to Mr. A. P. H. Trivelli of the Eastman Kodak Company.

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DIFFERENTIAL DIAGNOSIS OF AMŒBIC DYSENTERY AND CHRONIC ULCERATIVE COLITIS BY PROCTOSCOPIC EXAMINATION[1]

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AMŒBIC dysentery, like chronic ulcerative colitis, produces certain characteristic and unmistakable lesions in the rectum and sigmoid. Their appearance in many instances, even when repeated stool tests are negative, has provided sufficient evidence for a positive diagnosis. Those who are conversant with this disease know that such remedies as ipecac and its derivative, emetin hydrochloride, and the arsenicals such as treparsol, stovarsol, and arsphenamine, will often cure the diarrhœa and cause ulceration to heal within a period of 10 days. Such medication constitutes, therefore, a valuable therapeutic test which we often employ when stool examinations are negative although the ulcers are typical. The diagnosis has been uniformly confirmed by healing of the ulceration after treatment. Often when entamœba histolytica cannot be demonstrated in the stool it will be found in great numbers in the scrapings taken from the bases of the ulcers.

In the general run of cases the ulcers are discrete and the mucosa between them, although not normal, is so mildly inflamed as to seem relatively uninvolved. Of course, in many cases of active diarrhœa due to entamœba histolytica the rectal and sigmoidal mucosa is normal or but slightly hyperæmic. However, when the ulcers appear, they are typically discrete and have no characteristics which might lead to confusion with any other type of rectal ulceration, unless it is certain types of tuberculous ulcers and those associated with balantidium coli. As compared with chronic ulcerative colitis, the ulcers of amœbic dysentery, even in its earliest stage, are not as small nor as numerous; they are much deeper and, in the severe cases, they increase in size. In chronic ulcerative colitis, the miliary ulcers do not increase in size with severe attacks (although they become more numerous) and the large "secondary infective" ulcers seen associated, are not to be considered as a part of the characteristic picture.

The amœbic ulcer usually occupies a position on the prominent folds of the bowel wall, or involves the valves of Houston. The margins are undermined by the infiltration of the ulcerative process and the prominence of the ulcer is further increased by the accumulation on the base (composed largely of great numbers of entamœba histolytica) and projecting above the ulcer margin, presenting itself as a greyish-white covering over the center of the ulcer, known as the "white cap." This term is familiar, especially to those who live where the active disease is more prevalent. The white cap is easily swabbed away, after which the true base of the ulcer is revealed lying below the surface of the overhanging margins. This is the explanation of the "punched-out" or umbilicated appearance of the amœbic ulcer. It varies in size from about 2 or 3 millimeters in diameter (rarely so small) to a large sloughing ulcer 2 to 3 centimeters in diameter (or larger) with irregular margins and overhanging ragged edges, seen usually higher in the colon. In the cases seen in the Mayo Clinic, both of these extremes are rare; the usual ulcer is about 3 to 8 millimeters in diameter and there is usually a small zone of hyperæmia surrounding it. Of course, in the acute cases with severe prostration and excessive stools, sloughing and bleeding, it will be difficult to identify any such ulcer; the involvement is massive and diffuse and a single ulcer is seen only in the midst of a sloughing, bleeding mucosa. Such extensive disease is rarely seen in the Mayo Clinic because it is almost entirely associated with acute tropical amœbic dysentery which is seldom observed here. Experience in the Clinic has been with the more chronic type, and it is possible that this high percentage of cases with relatively uninvolved mucosa between the ulcers might not be duplicated in the experience of others, especially in those localities in which the acute forms of the disease are predominant. During the course of any year in the Clinic the stools of about 6

[1]Submitted for publication, April 23, 1927.

per cent of the patients registered are examined, and entamœba histolytica is found in about 10 per cent of these. Brown, in studying a series of cases of amœbiasis at the Mayo Clinic, divided them into three groups as follows:

Group 1. 153 cases, 28.7 per cent, in which active symptoms, dysentery or liver abscess, were manifested at the time of admission. In 34 per cent of these cases rectal ulceration was found on proctoscopic examination.

Group 2. 258 cases, 48.3 per cent, in which the chief complaint, or one of the complaints, was intermittent spells of diarrhœa, sometimes alternating with constipation. Associated with this, there were usually reflex abdominal symptoms, borborygmus and indefinite lower abdominal distress. In none of these was rectal ulceration present.

Group 3. 122 cases, 22.8 per cent, in which the entamœba was found without recorded history of dysentery. These were the pure "carrier" cases. They were discovered in the careful study of patients in whom all possible sources of infection were sought which might be factors in conditions such as dermatitis, anæmia, and indeterminate intestinal diseases.

A comparison of the rectal and sigmoidal lesion of amœbic dysentery with that of chronic ulcerative colitis shows that they are not alike in any particular, except that both represent forms of ulceration and inflammation of the colon; they should be confused only in the massive diffusion of the severer cases. However, even then, if the individual elements entering into the composite picture are analyzed, it will be seen that they are alike in no particular. In amœbic dysentery the ulcers are discrete and seldom smaller than 2 millimeters, coalescence being present only in the very severe cases. In chronic ulcerative colitis, diffusion is a feature in all cases from the mildest to the most severe (acute or chronic). The characteristic miliary ulcers occur in much greater numbers and are seldom larger than 1 millimeter in diameter. The active period of the disease is characterized by stages of diffuse inflammation, œdema, miliary abscesses and miliary ulcers. From the bases of these ulcers a specific type of organism (described by Bargen) can be isolated. The disease is prone to begin in the rectum and extend upward. There are often larger ulcers present, but these are due, in all probability, either to the invasion of the smaller ulcers by secondary infective organisms or continued activity of the diplococcus described by Bargen; possibly both of these factors are responsible. These ulcers in no way resemble those caused by entamœba histolytica. The former have irregular margins without the undermining, and a shallow base which is covered by a tenacious membrane, which does not heap up. In such cases, on rare occasions, entamœba histolytica has been obtained on examination of the stool, but scrapings from these ulcers did not show this organism and the therapeutic test has failed to incite healing. In fact the arsenicals often increase the activity of the disease in cases of chronic ulcerative colitis.

In many instances the characteristic ulcers will heal, either during a period of quiescence or after a course of vaccine treatment, leaving small pock-like scars behind as evidence of previous activity. The secondary ulcer, however, does not always respond to the vaccine and the resultant picture of pock-like scars between the larger ulcers is just as significant diagnostically as the original ulcers were.

Another point of contrast is the constant tendency toward uniform tube-like contraction of the lumen of the bowel in chronic ulcerative colitis. This is seen both on proctoscopic examination and in roentgenograms of the colon made after barium enema. In my experience such contraction is seen but rarely in amœbic colitis. The diameter of the bowel, therefore, tends to return to normal after the amœbic ulceration has been dissipated by treatment, except in chronic cases following repeated severe attacks. In the very severely affected bowel of amœbic dysentery, there is also distortion and scarring, but it does not result in the uniformly narrowed pipe-like colon seen after attacks of chronic ulcerative colitis. The tendency in most cases of the latter is for the contraction to remain permanently, although recently we have seen some restoration of the normal lumen after vaccine treatment.

The existence of such a disease as chronic ulcerative colitis is far from being universally admitted. In some comparatively recent and comprehensive descriptions of diseases of the colon it is not specifically mentioned; current articles sometimes pass it over. Many clinicians insist that it is an aberrant form of bacillary dysentery from which the typical organisms cannot be isolated; and cases have been recorded of the successful use of polyvalent antidysenteric serum.

The pathology of the disease is confusing because the postmortem appearance is radically different from the sigmoidoscopic manifestations. By the time death occurs, the mucosa is almost entirely destroyed and, in the bloodless tissue all traces of the distinguishing features of the disease are lost.

Descriptions of the lesion as seen through the sigmoidoscope are conflicting. It has been described as recognizable at first glance, as indistinguishable from that of bacillary dysentery, and as presenting a clear-cut clinical and pathological picture, by different authors and by the same author. In the course of more than 20,000 sigmoidoscopic examinations since 1919, I have examined more than 600 cases of chronic ulcerative colitis. I have observed what I consider the typical lesion in the untreated state and during its progression and its healing under treatment. My description (4) is, therefore, not based on an occasional observation, but on constant manifestations not presented by any other known disease.

Hurst has been unable to observe this type of lesion and fears that the disease in America is different from that seen in England. Indeed it was his suggestion that I might be confusing it with amœbic dysentery that prompted this paper.

I have not been able to find in the English literature a comprehensive description of the lesion as seen there through the sigmoidoscope; I can, therefore, make no comparisons. The clinical course, however, and the appearance at necropsy are practically the same here as in England.

Lockhart-Mummery describes the appearance of the lesions at necropsy and under the sigmoidoscope, and pays considerable attention to the larger and, as I think, less typical lesions "the size of a pea up to large irregular tracts." He suggests that the lesion seen with the sigmoidoscope is an earlier or milder stage than that observed at necropsy. He describes the former as "granular" and uses an illustration which is identical, in many respects, with my description.

The confusion that clouds the general attitude toward chronic ulcerative colitis will be cleared when observers of numbers of cases describe explicitly the appearance of the disease under the sigmoidoscope; then only will the chasm that lies between observation and conviction be bridged.

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OBSERVATIONS ON THE RATE OF URETERAL REGENERATION

Preliminary Report

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THE problem of repair following ureteral injury became interesting to me some years ago, when I witnessed in one of our charity hospitals, three ureteral accidents in a period of 3 months. Since these occurred while the patients were under the care of a gynecologist of experience and unquestionable ability, it follows that similar injuries must be observed in other clinics where the same extreme pathology is encountered. It must be admitted that many ureters could be saved if ureteral catheters were passed and left *in situ* during difficult pelvic operations involving large inflammatory and neoplastic masses. On the other hand, even with the utmost precautions, ureteral accidents are apt to occur from time to time.

Opportunities to attempt ureteral repair are very few, even with surgeons having large private and charity services, with the result that our knowledge of ureteral healing is poor. That healing and epithelization does occur with any of the numerous methods of anastomosis is an established fact, but the rate is unknown. Our knowledge of the rate of healing of a severed urethra anastomosed over an indwelling catheter, indicates a rapid and complete re-establishment of urethral continuity, usually within 10 days, so that the catheter may be safely removed at that period. The tendency of an epithelial lined duct to regenerate along a splint in the biliary passages and also in the vas deferens is well known. In the latter the sheath alone may act as a bridge and regeneration may progress with re-establishment of the lumen.

These facts led me to believe that epithelization and repair of a severed ureter would occur with equal rapidity, and this conviction led to the experiments detailed below.

The three ureteral accidents previously mentioned occurred in the course of very difficult gynecological operations. Two of these happened during radical Wertheim operations for carcinoma of the cervix. In both instances the ureters were exposed and followed down to the bladder, only to be ligated accidentally, when troublesome hæmorrhage from the uterine vessels completely obscured the field of operation. In one case the patient developed a complete anuria, and subsequent attempt to catheterize the ureters revealed bilateral occlusion. At autopsy these findings were confirmed. The second woman shortly after operation developed severe pain in the right renal region and cystoscopic examination revealed unilateral ureteral occlusion. Several weeks later nephrectomy was performed for hydronephrosis. The third accident was a complete severance of the ureter, which had been displaced by a large pelvic inflammatory mass. Following the dissection and removal of the adnexal mass, the ureter was found to be cut just below the brim of the pelvis. An anastomosis was immediately done according to the method of Van Hook. Urine discharged from the peritoneal cavity the next day, and continued until nephrectomy was perfomed several weeks later.

Bickham discusses 16 different operations for uretero-ureterostomy and all of these fall into one of two groups—end-to-end and end-in-end anastomosis. End-to-end anastomosis may be performed without a support, by transverse (Schopf, Cushing) approximation of the ureteral edges. Bovee's oblique and Van Hook's "elbowing" anastomosis are other methods of end-to-end repair without a support. The Tuffier and Kelly methods consist of suture over a ureteral support which is removed when the sutures are in place.

Markoe, Poggi, Kelly, and others have described methods of end-in-end anastomosis which differ from each other only in detail. Van Hook's uretero-ureterostomy by proximal ligation and end-into-side implantation is recommended by many as the best for all around use. Young advocates simple end-to-end suture over a ureteral catheter passed from the bladder to the renal pelvis.

McArthur described a method of ureteral repair, which I found to be very well adapted for experiment on dogs. This author left his catheters *in situ* for a period of 9 weeks, but he went on to say that although ureteral regeneration is known to occur, the rate of epithelization of the ureter is unknown. The method described below is similar to that described by McArthur.

The method of bridging with a ureteral catheter was used in these experiments because it seemed to be the method of choice, in view of our knowledge of the tendency of epithelial lined ducts to regenerate over a splint. The purpose of this paper is to recount observations on the rate of ureteral regeneration, and not to advocate the method described in preference to any of the other known methods.

In performing the operation, the main difficulty has been to prevent tearing into the peritoneal cavity, which usually caused the death of the dog within several days. The primary mortality was very high, so that the series of successful operations was small. However, a number of interesting observations were made, which it is hoped will be confirmed and added to in future experiments which are being contemplated.

TECHNIQUE OF OPERATION

Ether anæsthesia was used. The lumbar region was shaved and prepared with iodine and alcohol. An incision was made through skin, fascia, and muscles, to expose one kidney. The kidney was delivered and the ureter located and dissected downward, so that the middle third was exposed. In this portion was made a longitudinal incision long enough to admit two No. 5 ureteral catheters. One catheter was passed upward into the renal pelvis, another catheter was passed downward into the bladder, and the ends of both catheters were brought out through the wound. At a point 1½ inches below the longitudinal incision, the ureter was completely severed and the cut edges were brought together with one silk suture. The wound was closed by layers.

Experiment 1. The operation was performed according to the technique previously described. The upper catheter began to discharge urine immediately and continued to do so, until both catheters were removed on the fifth day. A urinary fistula developed in the wound and remained open for 3 weeks, although the amount of urine discharged became progressively less. During the fourth week the fistula closed and the wound healed completely. The dog was killed 4 weeks after operation.

Postmortem examination four weeks following operation. Necropsy revealed the kidney on the side operated upon to be one-half the size of the opposite one, and considerable subcapsular scarring was seen throughout. The peritoneum overlying the ureteral incisions was smooth and glistening and not thickened. Slight kinking of the ureter was noted, but otherwise there was little visible manifestation of the ureteral anastomosis. Palpation of the ureter revealed peri-ureteral fibrosis, limited to the area of anastomosis and ureteral drainage. Fluid injected into the lower ureter passed the area of anastomosis without obstruction, distending the pelvis of the kidney. Examination of the lumen showed two areas of constriction, one at the line of anastomosis and the other at the point of longitudinal incision for insertion of the catheters. The latter was more marked. The mucosa in the involved area was grossly unaltered and only slight dilatation of the upper ureter and pelvis was noted.

Sections of the kidney revealed evidences of interstitial inflammatory involvement, with only slight changes in the tubular and glomerular structures. Sections of the ureter in the area of operation were normal as compared with the other ureter, except for rather marked peri-ureteral fibrosis.

Experiment 2. The technique of the operation was exactly as described. On the fifth day the catheter leading from the kidney pelvis was removed and the catheter leading to the bladder was left *in situ*. Previously urine drainage through and around the upper catheter was good. Following this a urinary fistula persisted until the time the dog was killed 2 weeks later. The general condition of the dog was good throughout this period.

Postmortem examination two weeks following operation. The kidney on the side operated upon was one and one-half times the size of the opposite kidney. The consistency was softer, but otherwise the appearance was quite normal.

The peritoneal surfaces in the region of operation were smooth and glistening, but some thickening could be palpated. The ureter in the area of the incisions was markedly kinked and imbedded in a mass of dense scar tissue. A fistulous tract was found in this mass extending from the ureter to the outside, in which was found the lower catheter, extending down the ureter to a point several inches above the bladder. The fibrous periureteral thickening was fairly well limited to the upper ureteral wound and fistulous region, although it extended downward to the area of anastomosis, where periureteral scarring was much less marked. The ureter above the fistula and the renal pelvis were definitely

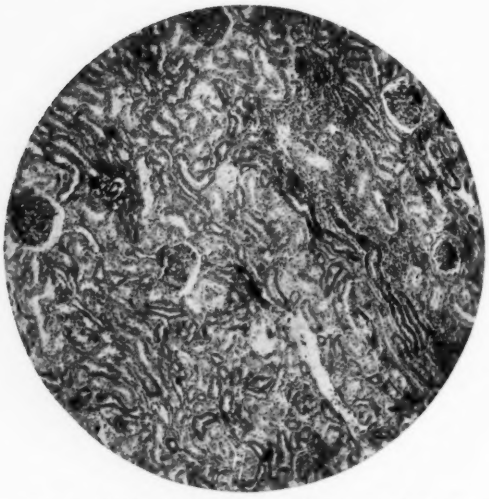

Fig. 1. Section of the kidney of Dog 1, showing interstitial inflammatory changes.

dilated. A ureteral catheter pushed up the ureter from the bladder, passed by the area of anastomosis, making its exit through the fistula. Likewise a catheter passed downward from the renal pelvis emerged through the fistula.

When the ureter was opened along its entire course, a fine annular scar, with practically no constriction, was found at the point of anastomosis. Above this point where the ureter was imbedded in scar tissue, the lumen of the ureter was slightly constricted and communicated with the fistula. The upper portion of the ureter was dilated.

Microscopic sections of the kidney and ureters were essentially the same as in the previous experiment, except for a much greater amount of periureteral fibrosis.

Experiment 3. The usual technique was used with the following exception. Instead of merely severing the ureter, about three-fourths of an inch was excised and the edges were allowed to remain the above distance apart, over the usual ureteral splint. One loose silk suture was used to prevent further retraction of the ureteral edges. Urine began to be expelled from the upper catheter at once. Usual closure by layers followed.

On the fourth day both catheters were removed. A urinary fistula developed in the wound, which continued to discharge urine until the dog was killed 3 weeks after operation. At that time a small clean fistulous tract remained and the general condition of the dog was good.

Postmortem examination three weeks following operation. Thickening of peritoneum overlying the affected region was noted, with a few easily torn omental adhesions. Both kidneys were grossly similar, as regard size, appearance, and consistency.

Fig. 2. Roentgenogram of Specimen 1, showing points of constriction at sites of ureteral incisions.

The affected ureter was thickened throughout its entire length. The site of the recent operative procedure was easily located because of the periureteral thickening and adhesion of the ureter to the surrounding structures. In this region (about ¾ inch), the ureter was lost in a mass of scar tissue. Above this point it was dilated to about one and one-half times the size of the ureter below. Dissection within the scarred area revealed perfect continuity, moderate fibrous thickening, and very little kinking. In the area of cicatrization, a small fistulous tract was discovered extending from the lumen of the ureter to the external wound. The silk suture was found in the lower portion of

the thickened scarred area, thus locating exactly the site of ureteral regeneration.

A ureteral catheter No. 4 passed upward from the bladder was obstructed at the site of anastomosis. Fluid injected through the catheter passed beyond the anastomosed area and escaped through the fistulous opening located about 1 inch above the point of obstruction. After the fistulous opening was closed with a purse string suture, fluid injected with considerable pressure passed upward and distended the upper ureter and renal pelvis. Following the above procedure, manipulation of the ureteral catheter resulted in its free passage by the affected area into the pelvis.

When the lumen of the ureter was opened, the area of regeneration was found to be constricted to about one-third the diameter of the portion below. This area measured about ¾ inch in length. About 1 inch above, the internal orifice of the ureteral fistula was easily found. The upper ureter and kidney pelvis were definitely dilated. The mucous surface in the affected portion was similar in gross appearances to the adjacent portions above and below.

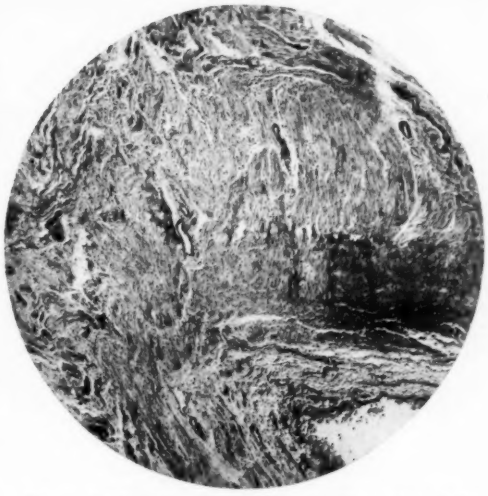

Fig. 3. Section of ureter of Dog 2 in the region of the anastomosis, showing marked periureteral fibrosis.

The three experiments cited were selected for report and discussion, because they demonstrate results which appear to cast some light on the rate of ureteral regeneration and epithelization. It would appear that the tendency is rather to overrate the time necessary for regeneration and canalization of epithelial lined ducts. In 2 of the above experiments (1 and 3), the splints were removed on the fifth day and in both instances ureteral continuity with a patent lumen was re-established at the time of necropsy, 3 and 4 weeks later. In one of these (Experiment 3) a gap of ¾ inch was left between the severed ureteral edges, while in the other (Experiment 1) the ureteral edges were approximated with only one suture. In these cases the amount of periureteral fibrosis was much less marked and the anatomical result much better than in Experiment 2 where the ureteral splint was left *in situ* for 14 days.

The evidence is very definite that ureteral repair and epithelization occur very rapidly, since a perfect anastomosis was found in dog 2 at the end of 14 days with the splint in position during the entire period. The fact that a successful anastomosis and canalization occurred after only 5 days of bridging, should emphasize the probability of sufficient regeneration at that period to insure re-establishment of continuity and lumen, even when a definite gap exists.

In the literature on ureteral anastomosis, great emphasis is placed on the prevention of leakage of urine at the point of anastomosis, and the statement is frequently made that leakage retards or actually prevents ureteral healing. It would appear from these experiments that splinting is the more important factor, although diverting the urine as was done with the upper catheter may have been an important factor in determining the rapidity of the healing of the severed ureteral edges.

The periureteral cicatricial reaction observed was in all probability caused more by the presence of the catheters, than by leaking urine and infection. Rapid closing of the ureteral fistula occurred when the catheters were removed within 5 days, demonstrating the desirability of a much shorter splinting period than that used by McArthur.

Some stenosis of the lumen may be expected with any type of ureteral anastomosis and is apt to be more marked if the method used resembles that advocated by McArthur. Stenosis should be combated by lowering the period of bridging, thus diminishing the amount of periureteral scarring. Ureteral dilatation would appear to be indicated in all

Fig. 4. Specimen Dog 3, showing constriction at point of ureteral regeneration with diffuse enlargement and thickening of ureter.

cases especially if a gap has previously existed. Dilatation should be performed as soon as possible because of the danger of contraction of the periureteral scar. The hydronephrosis and hydro-ureter, which is found in some degree following any ureteral anastomosis, may be rendered less marked by timely ureteral dilatation.

SUMMARY

1. Ureteral injury may occur during the course of difficult gynecological operations, and during the operation indwelling ureteral catheters should be used as a precaution against such accidents.

2. Ureteral regeneration, canalization, and epithelization occur rapidly when a ureteral splint is provided.

3. The period of splinting or bridging should not be unduly prolonged because of the tissue reaction aroused by the foreign body. It appears that a splinting period of 5 days is ample to allow re-establishment of ureteral continuity.

4. Ureteral stenosis may be expected with every case of ureteral anastomosis, and is more marked in cases in which an actual gap between the ureteral edges has previously existed.

5. Ureteral dilatation is always indicated following ureteral operations and should not be delayed too long.

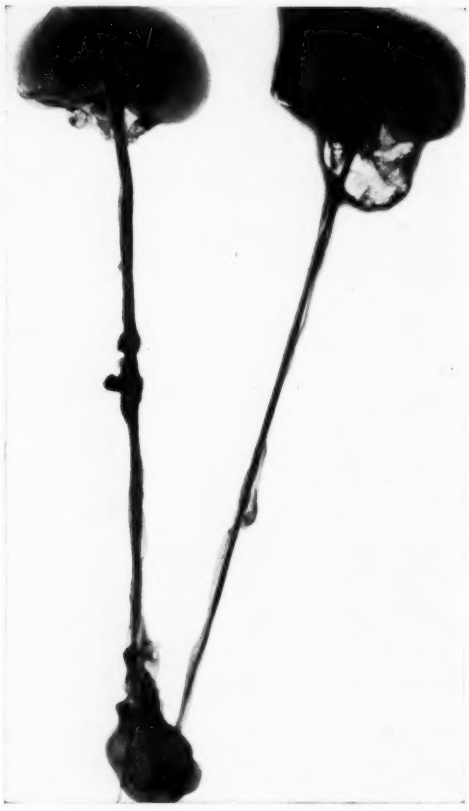

Fig. 5. Roentgenogram of Specimen 3, showing dilatation of the ureter more marked above the site of anastomosis.

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A CYSTOMETRIC STUDY OF THE PHARMACOLOGY OF THE BLADDER

With Additional Data Regarding the Physiology of Urination

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THIS work has been undertaken to determine the experimental value of the cystometer in the pharmacology and physiology of the urinary bladder, as well as to furnish further proof of the correctness of the ideas of bladder innervation used to formulate the clinical principles of the instrument, as given previously (4 and 5).

The cystometer (Fig. 1) utilizes the total innervation of the bladder in that as the viscus fills, the changing capacity with its pressure is measured and a curve recorded between the bladder capacity in cubic centimeters of water and the intracystic pressure in millimeters of mercury. In all previous attempts to determine bladder function, either isolated strips of muscle from different portions of the bladder have been immersed in solutions containing various drugs and their response recorded graphically, or a given constant amount of water has been placed within the bladder, the nerve supply of which is then stimulated either through dissection allowing direct electrical stimulation, or by various drugs used hypodermically, and the action of either type of stimulation determined by the contraction or relaxation of the bladder upon this given amount of fluid. Obviously this latter method is incorrect in that the bladder has no given capacity, and to measure its changing size and tonicity, it would be necessary during these changes to keep it completely filled. This is accomplished when the cystometer is used.

The work done so far in the clinical use of the cystometer has been based upon the fact that the bladder wall and its internal sphincter are chiefly in control of the sympathetic and parasympathetic nerves, and that, "in general, whenever sympathetic meets parasympathetic in a dual nerve supply to any organ or tissue, the effects of the two are antagonistic" (3). Upon stimulation the sympathetics, with outflow from the second dorsal to the third lumbar anterior roots, passing by way of the inferior mesenteric ganglions and hypogastric nerves, contract the internal sphincter and relax the bladder wall, and are therefore considered the nerves of bladder filling; whereas, the parasympathetics from the second and third sacral segments form the pelvic nerves, stimulation of which contracts the bladder wall and relaxes the internal sphincter, and are therefore the nerves of bladder emptying. One other action has to be considered, namely, that of the external sphincter, which is best considered as the resistance to the bladder wall external to the internal sphincter. The reason for this consideration is that there are in the so-called external sphincter so many influences that no one muscle can be held responsible for this resistance (Chart 1).

In further explanation of this idea, we have recently discovered in the clinical use of the cystometer an entirely new explanation for a type of urinary retention, which occurs when the lesion irritates or destroys the innervation of the external sphincter muscles (nervus pudendus chiefly). We would, in such instances, have left a normal sympathetic and parasympathetic system, but with a large retention due to the fact that the paralyzed or spastic levator prostatæ (anterior portion of the levator ani muscle) will not institute the downward and backward motion of the prostate and bladder base necessary to its emptying.

With a cystoscope just at the internal orifice, the trigonal portion of the bladder is seen to be pulled downward and backward (6, 7, and 8), when the patient is asked to strain as in voiding. The direct depression of the floor of the internal sphincter and the posterior urethral pull is due to the trigonal and in part to the recto-urethralis muscle, but the chief posterior and slightly downward motion is due to the levator prostatæ portion of

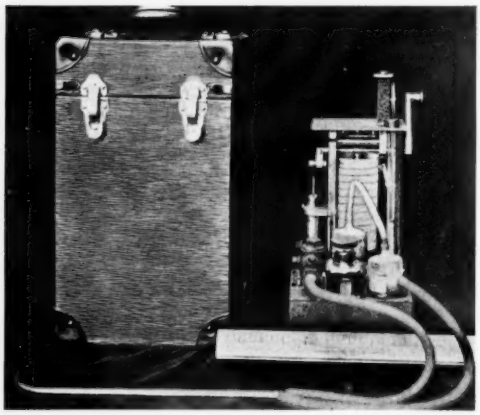

Fig. 1. Sanborn-D.K. Rose cystometer, with leather carrying case. The 1-foot ruler rests against the water container, above which the pump is shown. By the turning of the handle, fluid is pumped into the bladder through a two-way catheter which is attached to the output valve of the pump and to a mercury manometer. In this manner, with a graphic cylinder, the bladder fluid content and pressure are simultaneously recorded.

the levator ani muscle. In the normal male, micturition is *voluntarily initiated* and in our analysis the first motion in the act of urination is this voluntary depression of the internal orifice and prostatic urethra and then the involuntary action of the trigonal portion of the bladder, with which action the lateral walls of the orifice are relaxed by virtue of the loop muscles about it (6). The contraction of the trigonal muscle foreshortens the supramontane urethra and institutes the involuntary emptying contractions. Without the action of the levator prostatæ, we have obstruction by virtue of the curve of the posterior urethra and its consequent angulation at the membranous urethra. *Voluntary retention* is made possible through the levator prostatæ by elevation of the internal orifice which effects an increase in the sharpness of the curve at the deep transverse perineii muscle and triangular ligaments thereby increasing the resistant pressure here.

Female dogs were used exclusively in this study. Each animal was anæsthetized with paraldehyde by mouth, 1.5 cubic centimeters per kilogram of body weight being used. The cystometric curves were made after the dog was perfectly quiet, which required from 30 to 90 minutes in time. They were catheterized with a 16 French female metal catheter. The urine was examined each time to be sure there was no infection. Several pressure readings were always made with each dog before the administration of the drug under consideration. Invariably the capacity of a dog's bladder is from 15 to 20 cubic centimeters more in the first cystometric examination than in any subsequent curve. We attribute this to the stimulation of the first filling, resulting in an increased tonicity of the bladder wall. The same observation is easily made when irrigating the human bladder in which the patient almost invariably tolerates a much larger amount of the irrigating fluid the first time than during the several succeeding fillings. After the first reading a more or less definite capacity and intracystic pressure is established which is maintained quite indefinitely. One of these later cystometer curves we consider in each case as the normal intracystic pressure. At this point the drug under consideration is administered. The bladder is filled by the cystometer, with sterile water at a constant slow rate of filling. When the limit of capacity is reached the fluid is expelled around the catheter. This point is marked on the curves presented as *V. A. C.* (voids around catheter). The drugs were given in the order of their description and with definite times allotted between their administration.

In Chart 2 the inhibitory effect which atropin has upon the parasympathetic nerves is first shown. The reading starts with a zero pressure in an empty bladder and gradually mounts to 28 millimeters of mercury with a 55 cubic centimeter capacity. Having established a normal curve, we gave atropin sulphate 1/120 grain subcutaneously. Ten minutes later the terminal capacity had increased from 55 (in the normal) to 90 cubic centimeters of fluid, and the terminal pressure had decreased from 28 (in the normal) to 18 millimeters of mercury. We consider this distinct evidence of parasympathetic inhibition. Immediately following this reading, pilocarpin hydrochloride 1/5 grain was given subcutaneously and 6 minutes later a reading

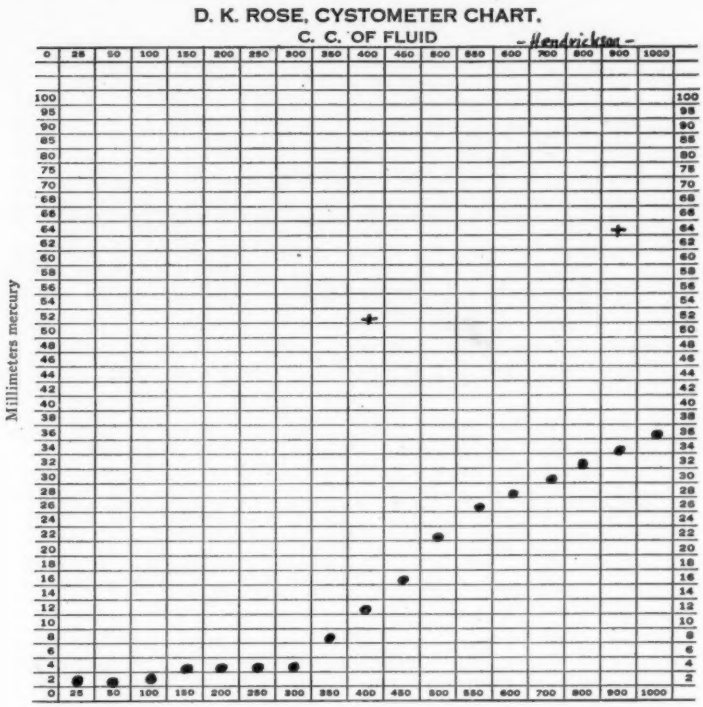

Chart 1. Dots show the intracystic pressures caused by contraction of the bladder wall alone. Crosses show the "straining" intracystic pressures. The cardinal cystometric points are: (1) Normal "first desire to void" at 150 cubic centimeters; (2) only slightly delayed "overdistention" pain at 400 cubic centimeters; (3) large capacity with mounting pressure and without expulsion about catheter; (4) high voluntary intracystic pressure—52 milligrams at 400 cubic centimeters—and 66 milligrams at 900 cubic centimeters; (5) low initial bladder wall pressure, due to large residual urine effect on bladder wall, i.e., muscular decompensation; (6) low emptying pressure taken as each third of the bladder emptied, also showing muscular decompensation of the bladder wall. In summary we have normal sensation, therefore normal motor autonomics, as both types of fibers travel in the same nerves; decompensation of the wall, but with more than sufficient voluntary pressure necessary to empty the bladder. Such a complex suggests bladder neck obstruction as the voluntary emptying through a catheter is of good force. Cystoscopic examination was negative except that when patient strained, the floor of the interior sphincter did not move downward or backward, i. e., the motions brought about by the levator prostatæ muscle. Cystometric diagnosis: lesion of anterior roots, low cord. Operation was done by Ernest Sachs whose operative note states "Conus found under the tenth spinous process; at the exit of its roots and studding them, many small masses resembling tubercles were found. No specimen removed."

showed that the pressure and capacity had both been decidedly changed. This definitely indicates the antagonistic action of pilocarpin, which is a parasympathetic stimulant.

The degree of antagonistic action in Chart 2 is better understood by comparing it with Chart 3 in which the normal pressure, having been established as indicated on the chart, 10 cubic centimeters of 4 per cent cocaine solution was introduced within the bladder. This resulted in a marked relaxation of the bladder muscle, which represents in degree the condition present when a cocaine solution is used prior to urethral or bladder manipulations

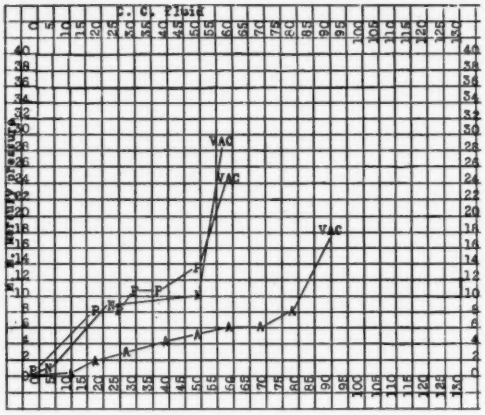

Chart 2. *N*, Normal; *A*, atropin; *P*, pilocarpin.

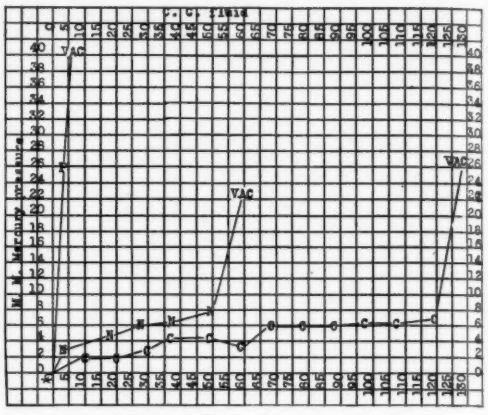

Chart 3. *N*, Normal; *C*, cocaine; *P*, pilocarpin.

as a local anæsthetic; that is, deceased tone of the bladder wall indirectly lessens pain as well as the local sensory action of the anæsthetic used. Immediately following, pilocarpin hydrochloride 1/5 grain was given intramuscularly, resulting in an overwhelming stimulation of the parasympathetics.

Epinephrin is one of the most important drugs we have in the study of the sympathetics. Elliott (2) believes its action in dogs and cats is different, in that he finds no inhibitor fibers in dogs, whereas they are definitely present in cats. We feel that they are undoubtedly present in man and in our work are shown to be present in the dog. We believe that epinephrin in small doses causes contraction of the bladder; in large doses, relaxation.

In Chart 4, after establishing the normal, we gave 1 cubic centimeter of 1:1000 epinephrin intramuscularly, and obtained full stimulation of the sympathetics, in that the "voiding around catheter" point remained high, and the capacity of the bladder increased showing a stimulant action of the sympathetics, i.e., inhibition of the bladder fundus and stimulation and contraction of the internal sphincter.

In Chart 5 the action of small doses of epinephrin is demonstrated, i.e., bladder contraction, following the intramuscular injection of 0.5 cubic centimeters of 1:1000 solution. If, with this type of reaction, the motor portion of the sympathetics could be cut out, we should then have left the amount of relaxation resulting from stimulation of the inhibitor fibers. Dale (1) carried through this idea with the use of ergotoxin, and for the same purpose we have used ergotamine tartrate (trade name "Gynergen"). Immediately after recording the epinephrin curve, 0.001 grams of ergotamine tartrate was given intramuscularly and we obtained a markedly increased capacity with lowered intracystic pressure as shown by the chart. This is of particular interest as in subsequent charts ergotamine tartrate, not influenced by epinephrin, produces distinct contraction of the bladder, and in this case, we can deduce only that the sympathetic inhibitors, stimulated by the epinephrin, are left in major control, the motor sympathetics being cut out by ergotamine tartrate.

Acetylcholin stimulates the parasympathetics, and when used immediately following ergotamine tartrate we find its definite influence as we would expect, i.e., a lowered capacity and a lowered "voiding around the catheter" point, or in other words, contraction of the bladder and relaxation of the internal sphincter upon which the counteraction of the motor sympathetics is cut out.

To test further the value of this method and to check the action of these drugs, Chart 6 is presented, in which the administration of ergotamine tartrate and epinephrin is reversed in order. The normal curve was established, which, in this particular instance, was

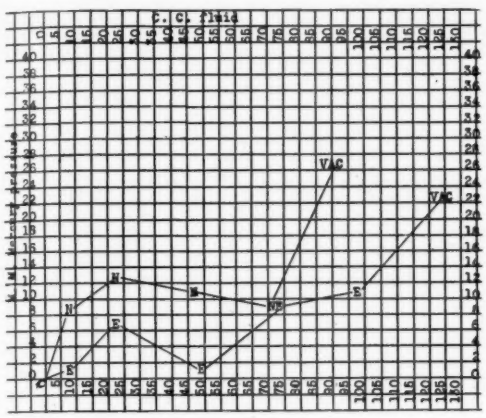

Chart 4. *N*, Normal; *E*, epinephrin.

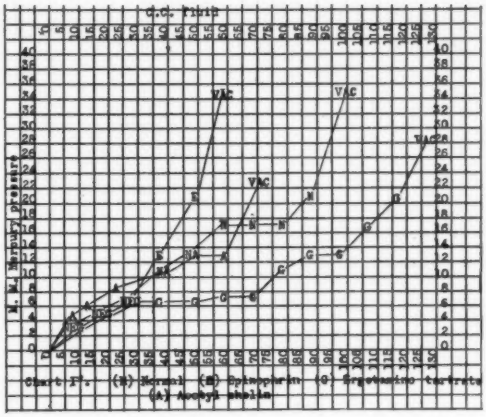

Chart 5 *N*, Normal; *E*, epinephrin; *G*, ergotamine tartrate; *A*, acetylcholin.

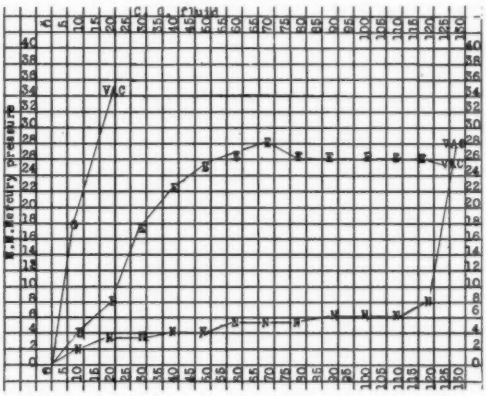

Chart 6. *N*, Normal; *G*, ergotamine tartrate; *E*, epinephrin.

of an unusually large capacity with low pressure. Following the injection of 0.002 grams of ergotamine tartrate intramuscularly, a curve was recorded after an interval of 20 minutes which showed an abrupt contraction of the bladder. Immediately afterward 1 cubic centimeter of 1:1000 epinephrin was given and 2 minutes later a curve was made which showed its antagonistic action to ergotamine tartrate by the distinctly increased capacity. However, there remained a residual high intracystic pressure from the ergotamine tartrate.

In Chart 7 a further composite picture is recorded, in that, after establishing the normal pressure, 1 cubic centimeter of pituitrin was given intramuscularly, producing bladder wall contraction by its direct action upon the muscle. Following this, 1 cubic centimeter of a 1 per cent solution of curara (approximate strength) was given intramuscularly. The animal soon became flaccid and with slowed jerky respirations. Five minutes after the curara was given, curve *C* was recorded which shows an increased capacity to 195 cubic centimeters with a "voiding around the catheter" pressure of 30 millimeters of mercury. This increased capacity probably represents a direct action of the curara on the bladder musculature. Following the curara by 10 minutes 0.002 grams of ergotamine tartrate was given. There was a slight decrease in the capacity, so that in 10 minutes 0.003 grams more of ergotamine tartrate was given, and 23 minutes from this time we obtained the curve recorded here, that is, a marked contraction of the bladder. Again, following the ergotamine 1.5 cubic centimeters of 1:1000 epinephrin was given intramuscularly, and in 4 minutes there was some release of the bladder contraction, in that the capacity increased to 50 cubic centimeters. It was noted following this, that there was a very slow settling to the base reading, which is indicative of sympathetic stimulation. The settling to the base line is much more rapid after parasympathetic stimulation.

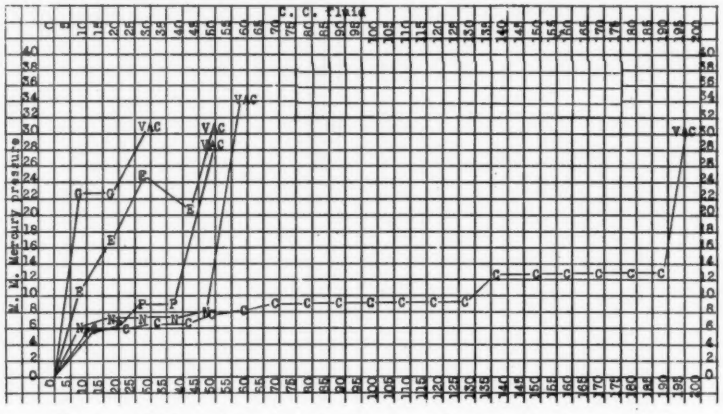

Chart 7. *N*, Normal; *P*, pituitrin; *C*, curara; *G*, ergotamine; *E*, epinephrin.

CONCLUSIONS

1. The cystometer furnishes a new method for studying the physiological and pharmacological actions of the bladder.

2. Results obtained by various drugs corroborate very satisfactorily the basic principles used in clinical cystometric work.

3. Atropin acts as a parasympathetic inhibitor while pilocarpin acts as a parasympathetic stimulator. Epinephrin in small doses causes contraction of the bladder, and in large doses causes relaxation. Acetylcholin is a parasympathetic stimulator. Pituitrin produces increased bladder wall tone.

4. The antagonistic pharmacological action between drugs can be beautifully demonstrated: the same antagonistic action has been found clinically in certain types of diffuse cord lesions.

5. Through the clinical use of the cystometer the following steps in the complete physiology of micturition in the male have been evolved: (a) Voluntary depression of the internal sphincter and prostatic urethra by the levator prostatæ muscle (to a less extent by the recto-urethralis); its assistance in opening the internal orifice, straightening out the curve of the posterior urethra and thereby lessening the resistant angle at the membranous urethra which is compressed by the deep transverse perinei muscle. (b) Contraction of the trigonal muscle, further opening the orifice by depressing its floor, and foreshortening the posterior urethra. (c) Contraction (or parasympathetic action) of the bladder wall, i.e., a contraction instituted by or with the contraction of the trigonal muscle, and having associated with it the relaxation of the loop muscles of the internal orifice.

We are greatly indebted to H. S. Gasser and R. J. Terry for their assistance in this work.

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THE FORM CHANGES IN THE HUMAN UTERINE GLAND DURING THE MENSTRUAL CYCLE[1]

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THE external appearance of the glands of the corpus uteri and their changes in form during the menstrual cycle have not been adequately visualized. The methods previously used, namely, the study of serial sections and, in one case, of wax plate reconstruction (Baumgartner, Nelson, and Dock, 1920) have been more or less adequate for the interpretation of the simpler gland forms but they do not give any conception of the great variability in the form of the complicated glands of the later stages of the uterine cycle.

The classical description of the uterine gland presented a slender tubule, coursing perpendicular to the surface and ending, simply or after dichotomous division, at the tunica muscularis. Sinuosity of occasional glands was accepted as normal.

Leopold (1877) correlated the slender tubular glands with the period immediately following menstruation and recorded their transformation into sinuous or alveolated glands as the succeeding menstrual period was approached. From our present point of view his carefully selected cases proved that such changes are normal but there were not many of them and the time was not yet ripe to establish correlations. It remained for Hitschmann and Adler (1908) to demonstrate the cyclic significance of the transformations undergone by the endometrium.

Opitz (1899), although cognizant of Leopold's work, described the papillary appearance of the hyperplastic uterine gland in early deciduæ and regarded it as diagnostic of pregnancy. While admitting the constancy of the papillary type of gland in pregnancy, Hartje (1907) pointed out that it is also regularly found in non-pregnant uteri during the period preceding menstruation. Hitschmann and Adler (1908), with a wealth of material at their disposal, showed that the so-called "decidual" glands regularly occur in the period preceding the menstruum and proposed them as one of the criteria of what they term the premenstrual stage. It was not until their work was understood that C. Ruge's "endometritis glandularis" came to be regarded as a normal stage of activity.

The portion of the endometrium lost at menstruation and the form of the remaining glands have received extensive consideration. It was said by Hitschmann and Adler, and verified by Iwase (1908), Schroeder (1914), and others, that the mucous membrane incurs little loss upon the first day of menstruation; the maximal sloughing of the functional layer (namely, that portion of the mucous membrane which hypertrophies for the implantation of the ovum) occurs upon the third day: usually at this time only the basal portions of the glands remain. Usually the fourth day shows the beginning of regeneration (Schroeder) and the fifth day a continuous surface epithelium overlying a low functional layer containing short, straight, reconstructed glands. Hitschmann and Adler (1908) and others have questioned the loss of tissue at menstruation in some cases.

METHODS AND MATERIAL

Our method utilizes free-hand sections 0.1 to 0.2 millimeter in thickness cut with an auto-strop razor blade from material in 80 per cent alcohol after prompt fixation in Zenker stock solution or the like. The sections are iodized, washed, and stained in Delafield's hæmatoxylin (before the addition of methyl alcohol and glycerin) diluted one part to five of water and one drop of glacial acetic acid added per 2 cubic centimeters of the diluted hæmatoxylin. The sections should be agitated occasionally to insure even staining. They are passed through tap water, dehydrated, cleared in oil of wintergreen (synthetic), and mounted in balsam. This method, recommended by Professor R. R. Bensley (Goetsch, 1910), gives an adequate idea of the external form of even the complicated pregravid glands and makes possible a rapid sur-

[1]This work has been conducted under a grant from the Douglas Smith Foundation for Medical Research of the University of Chicago.

vey of every part of an entire endometrium. Such a survey usually demonstrates regional differences which may not be neglected; it is a valuable, rapid method of diagnosing pathological material.

Observations upon thick sections such as these were confirmed by the study of whole glands dissected from pieces of fresh mucous membrane which had been placed in one-third concentrated hydrochloric acid and macerated for 12 hours (Schweigger-Seidel, 1865). The work has also been controlled by a detailed study of thin sections.

Three hundred specimens, which in the fresh state showed little or no gross pathology, were selected from those removed in the clinic during the course of 3 years. These were either entire uteri or frequently only fundi. The majority of these specimens showed some evidence of infection but such mild stroma inflammations do not appear to affect the glands as is obvious from a comparison with uninfected material. From this abundant collection sixteen mucous membranes have been selected as representing typical phases of the uterine cycle as described by Schroeder and others.

CLASSIFICATION

The first study of the duration of the menstrual cycle, based on records established *with scientific accuracy* (King, 1926), confirms the early findings of Foster (1889) and makes it obvious that the "regular twenty-eight day cycle" is very much of a fiction. King studied 17 women and kept accurate records for from 12 to 104 cycles in each case. The duration of the cycle of a given individual was found to vary about a single mode but the actual variability in duration of cycles was from 24 to 35 days, although there is a distinct mode in the curve for all cycles studied, at 27 to 28 days. Such findings, accurately established, mean that the statements of the average woman as to the usual duration of flow have very little scientific value.

More important is the fact that the various subdivisions of the cycle cannot be accurately fixed. Even in successive cycles of the same individual corresponding days after the flow are not necessarily exactly comparable; and specimens removed on corresponding days of the cycle may show marked differences from one to another especially as to the form and secretory activity of the glands.

Schroeder's scheme of the menstrual cycle outlined and illustrated by photomicrographs in his *Lehrbuch der Gynaekologie* (cf. Evans in Barker's *Endocrinology and Metabolism*, vol. ii, and Williams' *Obstetrics* for résumé) is at present the most satisfactory basis for subdivision. It may be summarized as follows:

1. *Proliferative phase.* Fourth or fifth to fourteenth days of the cycle. Slender tubular glands with high columnar epithelium. Progressively increasing mitotic activity in both glands and stroma. Correlated with the ripening of a new graafian follicle.

2. *Secretory phase.* Fifteenth to twenty-eighth day. Glycogen, mucicarmine positive material, and fat appear in the gland cells and then in the lumen. The glands become sinuous or saw-toothed. Stroma cells enlarge superficially. The vessels hypertrophy. Correlated with this phase is the development of the corpus luteum.

Schroeder's term "secretory" as applied to this stage is not distinctive, as Bartelmez (1927) has found that secretory activity is not confined to this period. As R. Meyer has pointed out "premenstrual" is very misleading. "Pregravid" is much more satisfactory and will be used throughout our descriptions.

3. *Desquamatory and regenerative phase.* First to fourth or fifth days of cycle. Following leucocytic invasion and pyckosis in the superficial mucous membrane, extravasation of blood and desquamation occur. Re-epithelization soon follows. Correlated with this phase is the degeneration of the corpus luteum.

We shall follow this except that it seems advisable to us to subdivide the last phase, separating the desquamatory and reparative processes. The latter intervenes between the first signs of re-epithelization and the restoration of a complete surface epithelium.

This scheme of Schroeder's, based upon his own material, of over 700 cases, and several hundreds more from the literature, serves as a norm according to which specimens may be classified by their resemblance to a given stage of the cycle regardless of the length of the menstrual period, duration of flow, and

other variable features. Thus, the fifteenth day of a thirty-five-day cycle may resemble the tenth day of the Schroeder classification and is thus regarded as belonging to the beginning of the proliferative stage. This provides also for those specimens removed after a 6 or 7 day menstrual flow which upon the fifteenth day of the cycle, for example, are likely to be more retarded than mucous membranes from cases with a 3 day flow at the last period.

DESCRIPTION

Early proliferative phase. CC 148, thirteenth day: The mucous membrane varies from 1.2 to 3.0 millimeters in thickness as measured in 80 per cent alcohol.[1] With the exception of a thin strip of lamina basalis (Schroeder) adjoining the muscle, the entire stroma has the appearance of granulation tissue. The glandular epithelial cells are high columnar and in the early stage of secretory activity. Mitosis is active in both the gland epithelium and the stroma. Occasional lymphocytes, eosinophiles, and plasma cells are to be found in the stroma. The appearance of a histological section of a similar stage is shown in Figure 1 (CC 251, eleventh day).

The glands are sparse or moderately abundant and show little variation in form (Fig. 2). They are slender cylinders with narrow lumina which expand uniformly from narrow superficial foveolæ toward the tunica muscularis at which they end in slight expansions or, after branching, in short vertical tubules. Bifurcation may occur in the basal half of the mucous membrane and is occasionally found superficially as well (Fig. 2, *Br. 1*).

From the portions of the glands surrounded by the denser fibroblastic stroma of the lamina basalis, vertical tubules (Fig. 2, *B.B.*) arise which project for varying distances into the granulation tissue stroma of the functional layer and which have no connection with the surface. However, since they reach a much greater length in older mucous membranes, we may assume that they eventually reach the surface and establish new glands, thus serving to increase the number of glands in later stages. Such outgrowths from the basal zone have not been previously recognized and we would suggest calling them *basal buds.*

CC 288, twelfth day: The mucous membrane is 1.9 to 2.1 millimeters thick and presents a later stage in that the stroma is composed of more mature connective tissue than in the preceding specimen. The gland cells are in the early phase of secretory activity. Mitoses are observed in both the gland and stroma elements. Plasma cells, lymphocytes, and leucocytes are observed.

Figure 3 shows entire glands from this endometrium isolated by acid maceration. The typical form of the early proliferative stage is seen. The basal ends of some glands branch irregularly; and slender basal buds may spring from the portion of the gland in the lamina basalis and extend a variable distance toward the surface (Gland 1, *B.B.*). It will be noted that the glands are somewhat more irregular than in the previous case and are more plump in form.

Late proliferative phase. CC 141, fifteenth day: The mucous membrane is 1.8 millimeters thick. An early phase of secretory activity is common in the glands and there is no evidence of the storage of glycogen. Mitoses occur in both the gland epithelium and the stroma. Lymphocytes are the chief infiltrating cells and there are a few small lymph nodules. The stroma reticulum (cf. Sekiba, 1923) has differentiated through the entire thickness of the mucous membrane, whereas in the two specimens previously described it was not present in the superficial granulation tissue.

Figure 5, taken from a thick free-hand section of this mucous membrane, shows moderately abundant straight glands which branch basally. Corresponding to the increase in thickness of the mucous membrane, the glands are longer. Basal buds (*BB*) are a conspicuous feature. They are somewhat dilated with secretion and have grown considerably farther into the overlying stroma than in the previously described cases. A study of serial sections of this specimen demonstrated that the basal buds are not connected superficially either with other glands or with the surface; furthermore, the mitotic figures in such basal buds proved they were actively growing.

[1] All subsequent statements of the thickness of the mucous membrane refer to measurements made on the material in 80 per cent alcohol. They were made in connection with a preliminary survey of the entire available endometrium with fine-pointed dividers under a binocular dissecting microscope.

We have here the clearest evidence as to the way in which the number of uterine glands might be increased twofold in the course of a few days. To be sure this specimen might be regarded as a very early phase of hyperplasia, but except for the numerous basal buds it appears perfectly normal. Figure 4 presents a photomicrograph of a thin section from a similar specimen.

Early pregravid phase. CC 61, twentieth day: The mucous membrane is 3.0 millimeters thick. The epithelium is still in the early stage of secretory activity. The stroma is composed of mature connective tissue and is permeated by reticulum fibers. Mitotic activity has decreased as compared with specimens from the twelfth and thirteenth days. There is evidence of mild infection. Figure 6 is a photomicrograph from a section of similar histological appearance.

The changes in gland form which initiate the pregravid period are presented in Figure 7 which is a photograph of a free-hand section. The glands have widened until the lumina are wider than one-half the diameter of the glands. While some of them are almost straight (*gl. 1*), most of them have become sinuous (*gl. 2*) or symmetrically sacculated in form. In other parts of this mucous membrane and in other specimens, the first appearance of wavy or irregular gland form is found in the basal one-third (*gl. 3*). Slender horizontal tubules arising from the bases of the glands branch extensively and there is some evidence of connections between tubules from adjacent glands. Two basal buds (*BB*), close to the surface and dilated with secretion, were observed. Since mitosis was still active, they would probably have reached the surface and not have become cystic glands.

CC 66, twenty-first day: The mucous membrane is 3.0–4.5 millimeters thick. The gland epithelium is in the early stage of secretory activity. Mitotic activity is considerably diminished. Figure 8 is a photomicrograph of a free-hand section illustrating the meandering course of a majority of the glands.

The next specimen cannot be regarded as normal but many of the glands were perfectly typical and can be used to illustrate the form of the pregravid gland.

CC 298, thirty-ninth day: The epithelium is not in the typical pregravid phase of secretory activity but contains abundant glycogen. Mitotic activity is markedly diminished as compared with the preceding specimens of the proliferative phase. The stroma is, however, œdematous, and the histological picture is that of the early pregravid phase. Cystic glands are not infrequent, and their presence may be regarded as an early stage of hyperplasia. The degree of infection is slight. It is included here because particularly good isolated glands were obtained.

Figure 9 shows several such entire glands isolated by acid maceration. Transitions are manifest from the slender, round, sinuous glands to the complex sacculated and folded ribbon-like types. Gland 1 is a basal bud which had not reached the surface and was dilating due to accumulating secretion. Figure 10 shows a ribbon-like gland photographed from two sides. Note the difference in appearance and the ease with which different interpretations of the same gland might be made, depending on the plane of section in which it was cut.

Late pregravid phase. CC 143, twenty-third day: The mucous membrane is 2.8–4.2 millimeters thick. It is typical of the pregravid (Schroeder's "secretory") stage (Fig. 11). The superficial stroma is somewhat œdematous and contains many enlarged cells of the decidual type. While there are many gland cells which are not actively secreting, there are others which are at the height of the secretory activity, typical of the pregravid phase. It presents a normal histological picture and agrees closely with our other pregravid specimens and also with Schroeder's (1926) Figure 44 taken from the twenty-sixth day. A normal corpus luteum in full bloom was obtained from this case.

In view of the descriptions of pregravid glands given by previous workers, their form is surprisingly irregular. In occasional groups of glands, the slender shape of the proliferative phase is retained, and the only evidence of pregravid change in their form is a slight rugosity in the walls. In many, there is a slender neck, prophetic of the neck of the decidual gland, opening into the uterine lumen.

Below the neck region the lumen is greatly dilated and the gland is more irregular. Here we find a flattened sinuous shape sometimes complicated by minor irregularities. In a few glands the walls are symmetrically sacculated. The lamina basalis is narrow and contains the slim branched tubules which represent the gland bases. Figure 12 presents a typical group of glands from this specimen.

CC 269, thirtieth day: This specimen is at the height of the pregravid phase. There is evidence of accumulation of glycogen and intense secretory activity. The superficial one-half of the endometrium is very œdematous but there is no evidence of blood extravasation or accumulation of leucocytes so characteristic of the period immediately preceding menstruation. There are many cells of the decidual type in the superficial stroma.

The glands present a very variable appearance. The most advanced forms are shown in Figure 13. In the superficial one-third they have a narrow lumen and are wavy or may be irregular or spiral in form. A few continue as narrow spirals but many of them are expanded so as to appear as narrow folded ribbons (cf. Fig. 10), reaching a diameter of 0.2 millimeter near the lamina basalis. There are, in other words, transitions from early forms of pregravid glands to most complex types, characteristic of end of menstrual cycle.

Menstruation. Distinct reduction in secretory activity, characteristic changes in the walls of the blood vessels, and extravasation of blood into the stroma, inaugurate a process of necrosis. It is still a matter of debate as to whether all of the functional layer is lost at each menstruation. The process at no time involves the lamina basalis, however, which itself may be of considerable thickness.

CC 107a, first day: The mucous membrane is 1.9–3.0 millimeters thick. Many glands still show secretory activity. As a result of the accumulation of extravasated blood the superficial stroma is loosening and disintegrating, leaving the necrotic free ends of the glands to project into the lumen of the uterus.

The glands are crowded (Fig. 14). While a few retain a slender wavy cylindrical shape throughout, the majority are oval in cross section and variable in width. Where the lumen

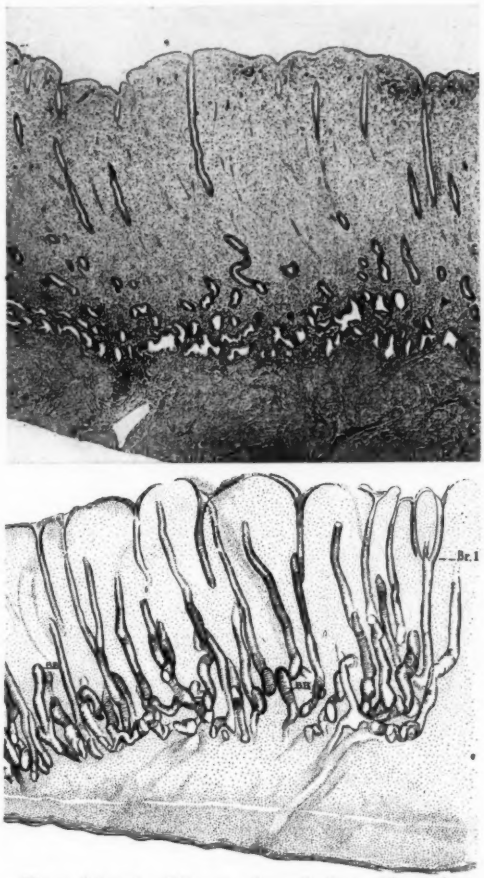

Fig. 1 (above). CC 251, eleventh day. Photomicrograph of an 8 μ section from an endometrium in the early proliferative phase. Characterized by numerous mitoses and a stroma resembling young granulation tissue. × 20.

Fig. 2. CC 148, thirteenth day. A group of glands drawn from a thick free hand section of an endometrium in the same stage as that of Figure 1. Note straight slender glands, branched basally, and basal buds (*BB*) arising from the glands of the lamina basalis and directed toward the surface. × 19.

is considerably enlarged, the glands appear as folded bands, narrow at base but wavy. Many are irregular in form even at this level.

CC 83, first day: The mucous membrane is 2.2–3.1 millimeters thick. The glands resemble an early pregravid type and show little evidence of secretory activity. The superficial one-half of the mucous membrane upon one side of the uterus is necrotic and sequestrating

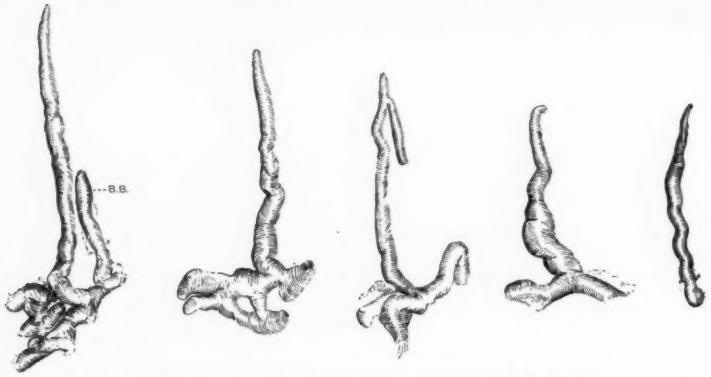

Fig. 3. CC 288, twelfth day. A series of whole glands isolated by acid maceration from an endometrium in the early proliferative phase. A basal bud is arising from the branched basal portion of Gland I. × 19.

(Fig. 15, *seq.*). The opposite side gives little evidence of oncoming menstruation beyond the great congestion of blood in the vessels and the absence of secretory activity. The intervening region is transitional.

This specimen illustrates that menstrual denudation may occur by sequestration as well as by the gradual crumbling of the superficial zone as illustrated in the two preceding specimens. It further shows that different areas of the same mucous membrane may at the same time present different stages of the menstrual process.

CC 101, second day: The mucous membrane is 0.6 to 2.8 millimeters. thick. This is due to the fact that in the depth of the fundus the mucous membrane is still intact (Fig. 16). Here we see a hæmorrhagic stratum compactum containing numerous decidual cells and traversed by the slender necks of the glands. The gland necks expand suddenly into flat-

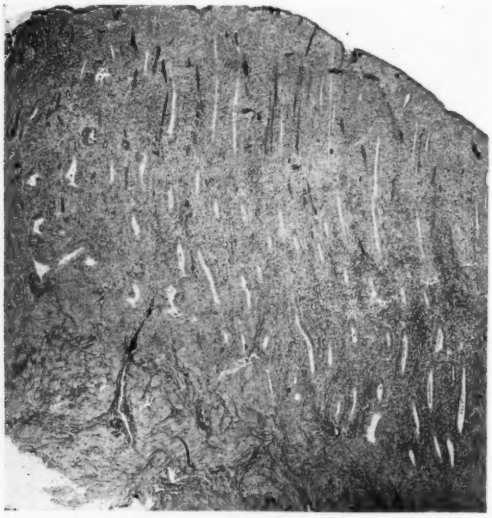

Fig. 4. CC 79, seventeenth day. Photomicrograph from a 6 μ section of an endometrium in the late proliferative phase. The stroma is more dense than in the early phase and the glands appear more numerous. × 20.

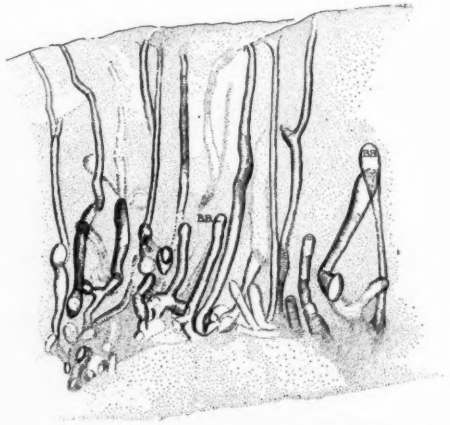

Fig. 5. CC 141, fifteenth day. Late proliferative phase. Thick free-hand section. There are numerous basal buds, somewhat dilated with secretion and of increased length. Note increase in width and length of the glands compared with the early proliferative phase (Fig. 2). × 19.

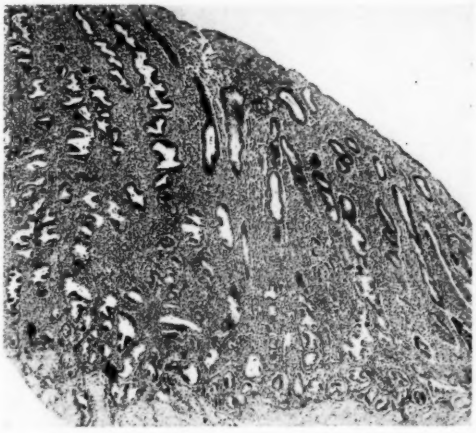

Fig. 6. CC 176, twenty-first day. Photomicrograph of a 6 μ section of a mucous membrane in the early pregravid phase. A stroma of organized connective tissue, sinuosity, and increased width of the glands, and decreased mitotic activity characterize this stage. × 20.

tened, much convoluted ribbons as the spongiosa is reached. We find all transitions from this condition to almost complete desquamation of the functional layer. This specimen also illustrates the necessity of making a complete survey of a menstruating endometrium rather than of studying a single block.

CC 93, second day: The mucous membrane is 0.5 to 1.0 millimeter thick. There is little or no evidence of secretory activity in the remaining portions of the glands, and the gland lumina contain a scanty secretion and a few blood corpuscles. Occasional patches of epithelium in the late stage of secretory activity may be observed. There is abundant blood in the superficial area; and lymphocytes are numerous. No mitoses were observed.

In the fundus, the glands are simple cylinders which divide as the lamina basalis is reached. Here there are isolated gland tubules near the tunica muscularis which we interpret as basal buds. Free glands may project for a considerable distance above the surface into the lumen of the uterus. In the region shown in Figure 17 part of the functional layer persists as is shown by the irregular form of the glands.

Repair. With the beginning of re-epithelization, the postmenstrual repair stage starts.

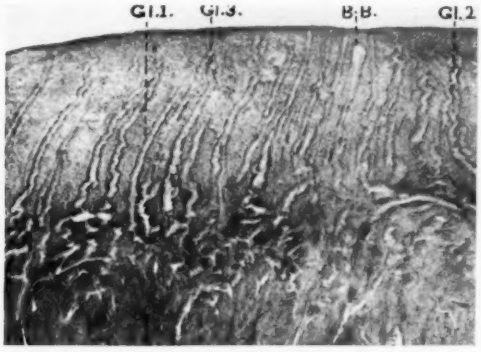

Fig. 7. CC 61, twentieth day. Photograph of a thick free-hand section of a mucous membrane in the early pregravid phase. Beginning sinuosity and alveolation in the bases of the glands is observed. × 15.

CC 161, fourth day: The mucous membrane is 0.5 to 0.8 millimeter thick. Histologically, the lamina basalis, which is all that remains of the mucous membrane, is normal (Fig. 18). Slight evidence of blood extravasation remains, and there is no lymphocytic or plasma cell infiltration. Many glands extend above the surface and occasionally they are bent over in contact with the adjacent stroma. In a few regions epithelization seems to have begun by the migration of epithelial cells from the mouths of the glands (Cf. x), and in one instance a layer of surface epithelium connects the mouths of two glands, proof of beginning epithelization.

Fig. 8. CC 66, twenty-first day. Photograph of a free-hand section of an early pregravid mucous membrane in which the spiral type of gland is common. × 15.

Fig. 9

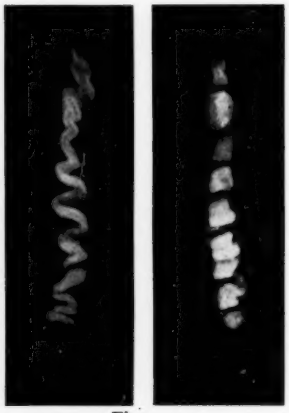

Fig. 10

Fig. 9. CC 298, thirty-nine days after the beginning of the last period. A variety of pregravid glands isolated from the mucous membrane of a patient whose menstrual history was irregular. Gland 1 is a basal bud dilated with secretion. Gland 2 is a ribbon-like type. Gland 3 is a slender, slightly modified type with rugose walls. Gland 4 is an extreme type of pregravid transformation. × 20.

Fig. 10. CC 298, thirty-nine days after the beginning of the last period. A ribbon-like gland photographed from two sides. Compare with Gland 2, Figure 9. × 20.

The decidual gland. If an ovum is implanted in the endometrium, menstruation does not interrupt the process of pregravid change: secretory activity continues in the gland epithelium, stroma changes are accelerated in a striking fashion, the stroma cells hypertrophying into the larger decidual cells, and consequently the compact and spongy layers are more clearly differentiated. There are no sharp differences between the pregravid mucous membrane and the early decidua: the pronounced decidual reaction, for example, is the only criterion by which a three-week decidua in our collection may be considered more advanced than one of our non-gravid 26 day specimens.

H 518 (estimated at 18 to 19 days by J. P. Greenhill, 1927). The decidua is 3.9 millimeters in thickness. Only an occasional gland is actively secreting; the remainder of the epithelium is in a resting stage. This is probably due to conditions which brought about the abortion. Numerous blood sinuses and a few areas of extravasated blood appear in the superficial portion of the mucous membrane. A division into compact and spongy strata can be observed.

The glands are sparse and frequently slender with ridge-like alveolations of the gland walls which produce localized increases in their diameter. Not all of the alveolations are symmetrical: they may appear as irregular ridges upon one surface. Since these are more common than the symmetrical alveoli, sections through the glands have a markedly irregular appearance. They do not present the typical saw-toothed condition in longitudinal section.

H 951: This specimen is a 3–4 weeks' pregnancy with a 4.0 millimeter embryo. The decidua is 6.8 to 11.6 millimeters thick. The surface of the decidua vera is dissected by irregular furrows. In the stratum compactum the glands appear as straight slender tubules, .03 millimeter in diameter, the epithelium of which is flattened and appears stretched. In the stratum spongiosum the glands widen suddenly and closely approximate each other. Their epithelium is in an advanced stage of secretory activity. The outer walls of the glands in the stratum spongiosum are frequently smooth except for narrow irregular invaginations of stroma elements which form the cores of the "saw-teeth" usually. Since other irregularities do not usually appear upon the surfaces of the glands, it may be assumed that these were eliminated by the expansion and mutual compression of the glands.

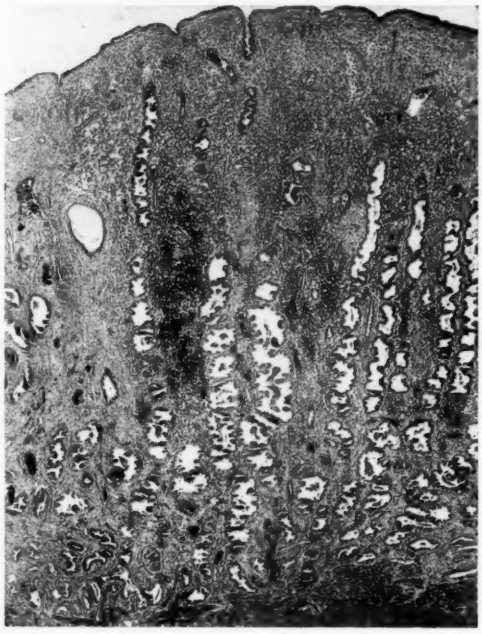

Fig. 11. CC 143, twenty-third day. Photograph of a 10 μ section from a late pregravid mucous membrane. Very few mitoses, and these in the stroma, the late stage of secretory activity, and beginning division into a stratum compactum and spongiosum characterized this mucous membrane. × 20.

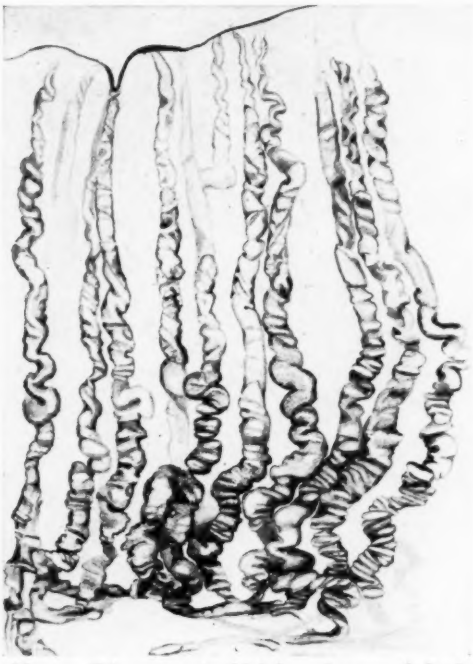

Fig. 12. CC 143, twenty-third day. A group of glands drawn from a thick free-hand section of the same endometrium as shown in Figure 11. Note the sinuous alveolated shape and slender necks opening into the uterine lumen. × 19.

It presents a stage intermediate between Grosser's (1925) figures 119 and 121.

H 465: This specimen is classified as approximately six and one-half weeks of age. The embryo measures 16.0 millimeters in crown-rump length. The decidua is 4.8 to 9.0 millimeters thick. Both histological and thick sections show a resemblance between this specimen and H 951 described above. It unquestionably represents a more advanced stage. The stratum compactum, now forming one-half of the entire thickness of the mucous membrane, is much wider and the necks of the glands which traverse it correspondingly more slender. The epithelium of the surface and of the necks is low and atrophied. The decidua lacks a well-defined lamina basalis.

DISCUSSION

The stage of repair consists in the epithelization of the wound surface by the conjunction of epithelial sheets which migrate from the mouths of the glands. As a result of the gradually increasing mitotic activity, the slender simple glands of the period of proliferation are reconstituted.

Throughout the proliferative period, the glands lengthen and the lumina widen. The rate of growth of the glands becomes more and more rapid as compared to the stroma and as a result the gland assumes a sinuous form. With the onset of secretory activity, the individual gland cells increase in size, adding still more to the gland surface.

During this time the number of glands may be increased by the growth of basal buds from the lamina basalis to the surface. It is possible that some of the basal buds may represent the remains of glands which did not join in the epithelization during repair period and so did not reach the surface; the majority take their origin from the bases of the glands.

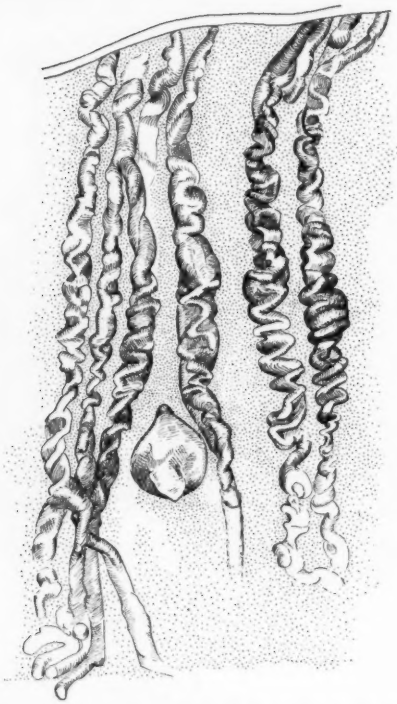

Fig. 13. CC 269, thirtieth day. Group of glands drawn from a thick free-hand section of a mucous membrane that had reached the height of the pregravid phase. × 19.

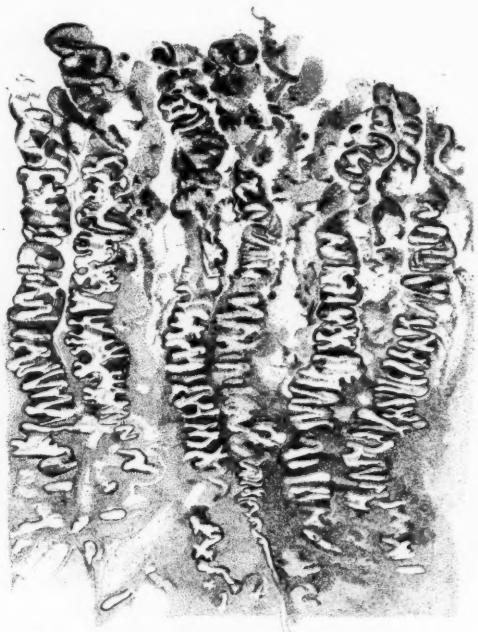

Fig. 14. CC 107a. Thick free-hand section from the first day of menstruation. The mucous membrane had undergone a marked pregravid transformation. The stroma has loosened and is engorged with blood; the glands are fairly resistant and project above the edges of the necrotic stroma. × 19.

Since basal buds are to be observed in practically all specimens of the proliferative stage we are justified in believing that the number of glands is normally increased during the cycle. A comparison of photomicrographs of the eleventh and twenty-third day cases (Figs. 1 and 11) makes this appear to be the case. This is, however, a difficult matter to decide. If we were to assume that the stroma remains stationary during the cycle it would be easy to show that the decrease in distance between the glands is simply a matter of their increase in diameter, but this assumption is false because we know that the uterine mucous membrane doubles or triples in thickness during the pregravid period as compared to the period of repair and thus involves a material increase in the stroma. The stroma cells are separated by an accumulation of œdema fluid. In order to prove, then, that the number of uterine glands increases during the cycle, it would be necessary to determine the ratio between the stroma growth and increase in glandular surface. This could be done only by studying the statistics of many hundreds of normal cases. The alternative would be to count every gland in a large series of normal uteri with similar histories removed early and late in the cycle.

The gradual cessation of proliferative activity during the latter half of the cycle leaves some of the basal buds, which may be very numerous (CC 141, Fig. 5), stranded at a variable distance between the lamina basalis and the surface. When pronounced secretory activity is inaugurated in the glands, those buds which have not reached the surface are dilated, for the only path by which the secretion could reach the lumen of the uterus is by way of gland tubules in the

Fig. 15. CC 83. Photograph of a block of tissue in alcohol from the first day of menstruation. The mucous membrane shows different stages of the process. SEQ indicates an area in which sequestration is occurring. The opposite area is hyperæmic while the transitional area is hyperæmic and necrotic. Evidently it will next be affected by the menstrual process. × 15.

Fig. 16. CC 101. Photograph of a thick free-hand section from the second day of menstruation. An area of intact mucous membrane is shown which grades off to almost complete denudation, illustrating that necrotic changes do not go on at the same rate throughout the endometrium. × 20.

lamina basalis. The peripheral dilatation of such basal buds shows that secretion does not follow such a course.

The uterine glands differ from most other glands of the body in their periodic intense proliferative activity, their separation from each other by an abundant stroma, their very delicate connective tissue sheath, and their periods of heightened secretory activity. The combination of these factors naturally results in irregularities in the form of the glands; budding from the gland walls, union of buds from adjacent glands in the basal zone, and branching.

In their pregravid transmutation, the changes which the glands undergo are purely fortuitous, being a combination of the circumstances of torsion, degree of secretory

Fig. 17. CC 93. A photomicrograph of an 8 μ section from the second day of menstruation. Little remains besides the somewhat sinuous and alveolated basal portions of the glands in a zone of the functional layer overlying the lamina basalis. × 20.

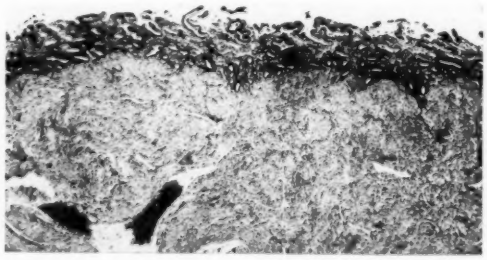

Fig. 18. CC 161, fourth day. The stage of repair. Only the lamina basalis remains. At *X*, epithelial cells are migrating from the mouth of a gland to re-surface the mucous membrane. × 20.

TABLE I.—CLINICAL DATA ON THE SPECIMENS DESCRIBED

CC No.	Day of cycle	Usual length of cycle, usual duration of flow	Age of patient; number of pregnancies	Duration of symptoms	Pathological diagnosis	Specimen studied
148 (prolif.)	13	28/3	27 v-para	9 mos.	Uterine fibromyoma; bilateral salpingitis	Corpus fundus.
288 (prolif.)	12	28/4	18 i-para	5 mos.	Pyosalpingitis	Fundus.
141 (prolif.)	15	28/4–5	44 viii-para	6 mos.	Fibrosis uteri	Whole uterus.
61 (pregrav.)	20	28–30/3	 ii-para	3 weeks	Pelvic peritonitis	Whole uterus.
66 (pregrav.)	21	28/4–5	23 i-para	7 weeks	Pelvic peritonitis	Fundus.
298 (pregrav.)	39	28/4–5	37 i-para	Acute onset	Fibrosis uteri; salpingitis	Corpus fundus.
143 (pregrav.)	23	?	29 o-para	6 weeks	Pelvic peritonitis	Whole uterus.
269 (pregrav.)	30	28/6	35 ii-para		Fibrosis uteri	Whole uterus.
13 (mens.)	1	28/3	24 o-para	??	Pelvic peritonitis	Corpus fundus.
107a (mens.)	1	28/3	32 iii-para	1 year	Ibid.	Corpus fundus.
83 (mens.)	1	28/2–3	35 ii-para	6 mos.	Ibid.	Whole uterus.
93 (mens.)	2	28/7	31 ii-para	3 weeks	Fibromyoma; salpingitis	Corpus fundus.
101 (mens.)	2	21/?	49 o-para	2 years	Pelvic peritonitis	Whole uterus.
161 (mens.)	4	28/3–4	35 iii-para	4 years	Ibid.	Corpus fundus.
H 518 (dec.)	3 weeks' decidua	?	31 o-para	??	Abortion	Entire decidua.
H 951 (dec.)	3½ weeks' decidua	?	22 ?	??	Fibromyoma	Whole uterus.
H 465 (dec.)	?	?	?	??	Fibromyoma	Whole uterus.

activity, differences in the rate of growth between epithelial and stroma elements, and pattern of the investing blood capillaries: these factors may vary in their effect and as a result the eventual form of the gland varies. Symmetrical spiral glands, such as have frequently been described from study of thin sections, are rather uncommon in our material.

In Figures 11 and 13, taken from pregravid mucous membranes, there are suggestions of slender necks interposed between the convoluted portion of the glands and the surface, and traversing the compact layer. These slender necks are the forerunners of the elongated necks of the decidual glands which are lengthened after the implantation of the ovum as a result of the hypertrophy of the decidual cells in the development of the stratum compactum. Such a process of hypertrophy increases the thickness of the compacta and so the epithelium of the glands adjoining the surface is stretched out and the diameter of the lumen decreased.

Secretory activity is accelerated in the decidual gland, and as the outlet is perhaps restricted, secretion accumulates to a greater extent than before. The glands come into contact with one another and the external irregularities are more or less smoothed out by mutual pressure. The original foldings of the wall nevertheless persist as serrations projecting into the lumen. Thus we have the sawtooth pregnancy gland to which Opitz called attention in 1899.

SUMMARY

During the period of proliferition, the uterine gland is characterized by its slender, cylindrical shape with a lumen less than one-half the diameter of the gland. Usually the lumen is somewhat greater basally but even at this stage irregularities are encountered.

The simple tubular glands may end in slight dilatations at the base of the mucous membrane; or they may divide at any point in their course, but this is uncommon except in the lamina basalis. Rarely we see two glands unite and the single trunk extend to the tunica muscularis. In the basal zone, branches of the second or third order may be found and they may follow a course parallel to the muscle layer. These ultimate branches are slender tubes, sometimes of considerable length. In this proliferative stage basal buds are observed, appearing first in the basal portion of the functional layer and projecting toward the surface. The later the stage in the cycle, the longer the buds usually are.

As growth progresses, increase in width of the glands occurs, bifurcated glands are more common and undulations or symmetrical alveolations appear first in the basal part of the functional layer and gradually extend throughout the glands. Further changes are fortuitious and the final shape assumed by the pregravid gland is variable, depending upon secretory activity and differences in growth between the stroma and gland epithelium. These glands may be circular or oval in cross section, and follow a spiral or undulated course, with occasional buckling of adjacent limbs upon one another at different angles. In many mucous membranes, an undulated ribbon-like gland predominates. A few glands, even in the most pronounced pregravid mucous membranes, remain slender and unchanged save for a slight rugosity of their walls. The tubules of the lamina basalis usually remain unchanged.

During the necrosis accompanying menstruation, the glands are more resistant to this necrotic process than is the stroma, and as the necrosis progresses the glands can always be observed protruding above the level of the stroma.

In repair, epithelization occurs by migration of the epithelial cells from the mouths of the glands; and this process is aided by the tendency of the projecting glands to bend over upon the denuded surface. Mitotic activity begins at once immediately causing changes in the mucous membrane.

The typical decidual gland is characterized by two features: (1) a long slender neck traversing the stratum compactum, and (2) an almost smooth exterior in the stratum spongiosum which has resulted from pressure and dilatation. The original irregularities persist as projections into the lumen.

Acknowledgment is due Dr. Geo. W. Bartelmez, under whose supervision the present problem has been undertaken, for many of the illustrations included, for criticism in revision of manuscript, and for constant encouragement. We are also indebted to Miss Agnes Nixon for the drawings which accompany the text and to Miss C. M. Bensley for aid in the preparation of material.

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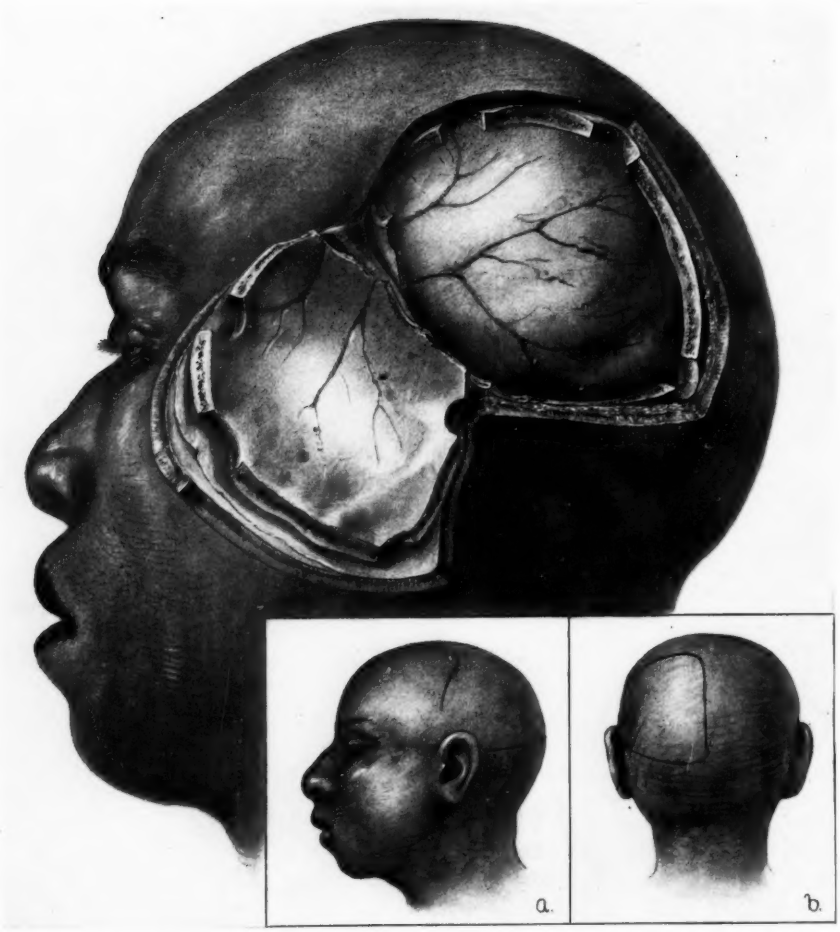

Fig. 1. The combined soft tissue and bone flap are on their pedicle. The vessels of the dura run from before backward.

Brain Surgery.—Howard C. Naffziger.

CLINICAL SURGERY

FROM THE DIVISION OF NEUROLOGICAL SURGERY, UNIVERSITY OF CALIFORNIA

BRAIN SURGERY

With Special Reference to Exposure of the Brain Stem and Posterior Fossa; the Principle of Intracranial Decompression, and the Relief of Impactions in the Posterior Fossa

By HOWARD C. NAFFZIGER, M.D., F.A.C.S., San Francisco
From the Division of Neurological Surgery, University of California Medical School

THE fascination of brain surgery lies in its difficulties. More than in the surgery of other parts, the mere opening and closure of a wound is a major procedure. It involves a difficult approach through exceptionally heavy and resistant structures to organs vital, delicate, and readily traumatized. It is laborious, time-consuming, detailed work with constant possibilities for hæmorrhage. The surgical treatment of the lesion itself often involves less time and effort than the exposure of it and the closure of the wound. The vascularity of the coverings and the special technical methods required to open the skull without injury to its contents both present their problems and their risks. For the future of the patient, proper closure is of the highest importance. On the surgeon it makes special demands. The slow, painstaking, detailed closure at the conclusion of a trying operation demands a self-exacting thoroughness not often called upon in other situations. More rapid but less detailed methods of repair bring in their train late hæmorrhage, herniations, brain damage, fungi, and hideous, harmful protrusions and scars. Training in this branch of surgery necessitates a degree of gentleness and attention to detail seldom acquired in the surgery of less delicate structures. Special methods are demanded for the control of bleeding and much experience in avoiding it. The elaboration of the technique of neurological surgery is evidence of the necessities though simplification of technique is always desirable.

Since the days of Lister, the osteoplastic bone flap of Wagner with its wide exposure has replaced the measurements of cranial topography and the selection of a much debated localizing point for a trephine opening. Likewise craniectomies have given way to plastic operations upon the skull except in the subtemporal and suboccipital regions. In these areas where other structures than bone may give adequate protection to the brain, such openings have their especial decompressive advantages. The temporal and cervical muscles act as protective coverings and at the same time restrain excessive or harmful herniations. Brain herniation through properly placed decompressions will cause no disabling symptoms. Operative procedures tend to become standardized. While for decompressions and approaches to near-by structures these craniectomies have especial advantages, the plastic operations are generally used for the cranial vault.

For operations upon the hemispheres—the parietal, frontoparietal, and frontal osteoplastic flaps are used. All have their bases in the temporal region. With the thin squamous portion of the temporal bone in this location they break back readily. The temporal muscle and fascia act as a hinge. With the flap reflected, removal of that portion of the bone beneath the temporal muscle permits leaving a decompressive opening after the flap has been replaced. These large flaps permit of wide exposure. Elevation of the frontal and temporal lobes gives access to the structures of the chiasmal region. The entire anterior fossa and the anterior portions of the middle fossa can be reached.

Less systematic attention has been given to surgical approaches to those structures in front of the cerebellum and between it and the third ventricle. This portion of the brain stem, the pons, tentorium, and pineal region, has received little notice. The surgery of this area involves special considerations. The principle of decompression to permit expansion outside of the cranial cavity is old. Yet within a certain part of the cranial cavity impactions occur.

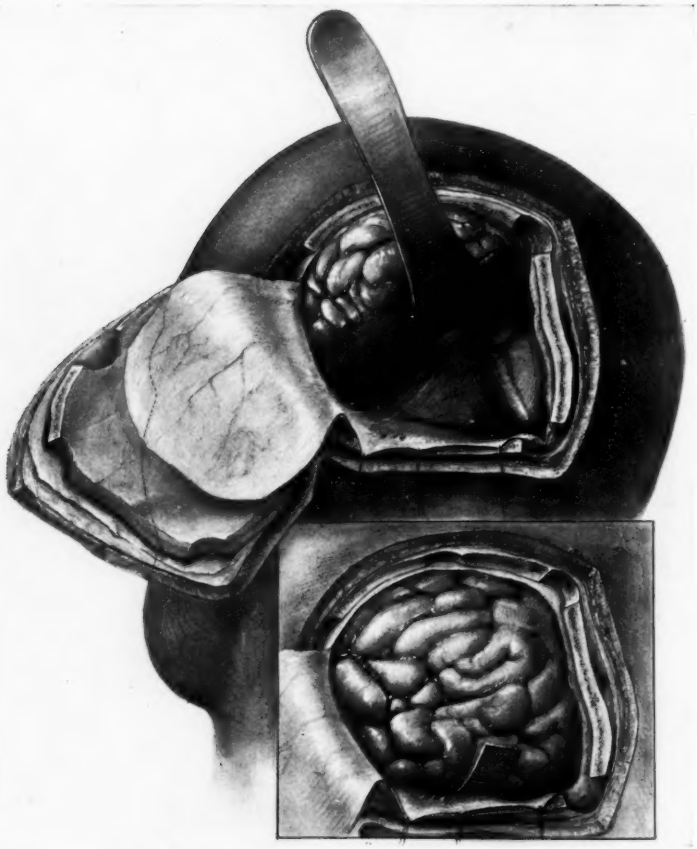

Fig. 2. The flap of dura is turned aside on its pedicle with blood supply unimpaired. The posterior lobe is retracted forward away from the tentorium.

Decompressive craniectomies of the lower portion of the occipital bone do not always relieve the pressure even when due to tumors in the posterior fossa. Persistent blockage of the peripontine pathways may persist. Enlargement of the posterior fossa below by suboccipital craniectomy is often disappointing for this reason.

The subtentorial space may be enlarged by wide opening of the tentorium or by section of the tentorium including the incisura tentorii. The approach is best made from above, through what we have termed the occipital flap. The field of usefulness of this operation has widened in that it also serves as a supratentorial approach to certain infratentorial tumors. It permits access to the pons, to all tumors which spring from the tentorium and the posterior half of the falx, to the entire occipital lobe and all the midline structures. Ready exposure of the upper and anterior surfaces of the cerebellum is made, areas which cannot be uncovered by a suboccipital operation. Enlargement of the posterior fossa gives added opportunity for expansion upward. The brain stem is no longer crowded down into the foramen magnum. Expansion upward even of large masses beneath the occipital lobes gives no symptoms and the blockage of peripontine fluid pathways with hydrocephalus is relieved. Impaction of the brain at the incisura often demands unusual methods to procure relief from pressure.

PREPARATION OF THE FIELD OF OPERATION

Shaving of the scalp is invariably performed on the morning of operation. Earlier shaving particularly if not carefully done may cause irritation, or slight scratches may form ideal nesting places for staphylococci. Careful shaving is an important step in the mechanical cleaning of the scalp. When combined with equally detailed scrubbing with soap, water, and alcohol, the use of other antiseptics can be left to the whim of the operator. Careless and rough scrubbing causing minute abrasions of the scalp is to be avoided.

ANÆSTHETICS

In this country while ether is the most favored anæsthetic, local anæsthetics are being used more and more in the surgery of the central nervous system. In our experience ether has been highly satisfactory. Long periods of anæsthesia are common. It is our impression that when properly administered, little difficulty can be justly laid to the ether anæsthesia. It is noteworthy that postoperative pneumonias are more rare after it in neurosurgical cases than in other types of surgery as reported by Cutler and Hunt (1), from the Peter Bent Brigham Hospital, and by Terry (2), from University of California Hospital. It is our impression that children stand long periods of ether less well than adults. Even in the longest operations on adults other more likely causes could always be found if the condition of the patient was poor. Cranial operations are in many ways well adapted to the use of local anæsthetics. Only the structures external to the skull need to anæsthetized. While the sound and feeling of the work on bone is unpleasant and may be startling when bone is fractured, it is not painful. Likewise ordinary handling and cutting of the dura is without sensation. The brain is of course insensitive.

Bleeding is lessened by the injection of a local anæsthetic with or without adrenalin as contrasted with the fact that there is apt to be increased congestion with ether. Wound healing in our experience has been equally good with both. It is not an uncommon experience to find that advocates of local anæsthesia use considerable amounts of drugs having general effects, particularly morphine and scopolomine. This is hardly local anæsthesia and certainly such drugs in individuals prone to respiratory difficulties from pressure should be used guardedly if at all. In our own experience, ½ to 1 per cent novocaine with 3 drops of 1:1000 adrenalin to the ounce has been used for infiltrating the scalp and for the deeper injections between pericranium, galea, and scalp. Lessened tendency to scalp bleeding occurs, but another important factor in lessening bleeding is the use of a position in which the head is higher than the body though not necessarily a sitting position. In the event of respiratory difficulties, it is desirable to be able to lower the patient's head.

Fig. 3. The cerebellum and nerves from the base of the brain are exposed after incision of the tentorium.

As to the choice of anæsthetic in an individual case: While judgment changes from time to time, it is our custom to consider local anæsthesia preferable in stuporous patients, especially in those with respiratory difficulties or very high degrees of pressure, and in others who may themselves prefer it. Likewise it is favored in patients with marked cardiorenal disease or pulmonary infections. The mere fact that an operation can be carried through with little or no pain under a local anæsthetic is not to our mind a sufficient reason for invariably insisting upon it. If in such a case the patient is sweating or exhausted and worn out at its conclusion one can hardly feel it is altogether satisfactory. It requires a considerable degree of equanimity and fortitude for a patient unfamiliar with his surroundings to submit to a brain operation under local anæsthesia. In special instances a light general anæsthetic has been used for the latter portions of long operations. For the use of ether the intrapharyngeal method has met all requirements.

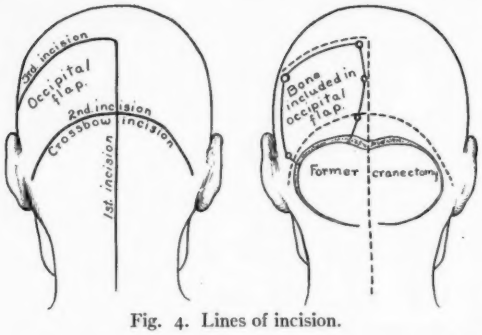

Fig. 4. Lines of incision.

THE GENERAL TECHNIQUE OF OSTEOPLASTIC FLAPS

Selection of the site of incision taking into account the area to be explored and leaving an adequate pedicle for the flap circulation and marking of the site should precede a firm draping of the field. Cross hatching of the line of proposed incision will facilitate proper matching of the margins upon closure. Digital pressure of assistants on each side of the incision is used to control bleeding and retract the margins of the wound, while straight fine-pointed hæmostats are applied to the fibrous under layer of the scalp at frequent intervals, usually about 1½ centimeters. As these clamps are laid back, the vessels of the scalp though they may not be included in the bite of the clamp are compressed. The scalp of the flap itself may be controlled in the same way or its base may be constricted by means of a special clamp.

For primary bone openings a broad perforator, the point of which will pass through to the dura while the broad portion is still engaged, is safe.

If the operator is careful to test bone thickness by percussion he will avoid possible accidents when dealing with the paper thin areas occasionally met. In placing the perforator openings it will be found that it is desirable to have the base of the bone flap near its hinge narrower than the free margin. If the two perforator openings nearest the base are placed to keep this in mind the flap when replaced will lie in position more satisfactorily. Five perforator openings in all are usually sufficient. The perforator openings may be enlarged with a burr of the same size. Motor-driven instruments are preferred by some but add greatly to the armentarium and to sterilization, none to the safety, and save but little time. With properly sharpened instruments the effort of making the openings is slight. Larger burrs are required to bevel the openings properly when the bone is unusually thick. Narrow, long curved periosteal separators are used to separate the dura from the bone prior to passage of guides for Gigli saws. With them the dura should be freed for the entire distance between openings. Two thin ribbon guides of spring steel with blunt points may be passed between adjacent openings. To a hook on one of these next the bone, the Gigli saw is attached and drawn through. The second guide lies against the dura and protects it from the saw. With the Gigli saw, the bone is cut from within out and beveled outward. It is well not to incise the galea and pericranium deliberately prior to this stage, as, if done, it will be found that venous oozing from bone will occur and there is also a greater tendency for the soft tissues to strip from the bone of the flap. It is desirable to use fairly fine rather than coarse saws, for though the latter cut faster they permit the flap to settle unduly when it is replaced. The base of the flap may be fractured back, but when the bone is heavy as in the occipital flap it may require special cutting with saw or bone-cutting forceps. Bleeding from the bone is controlled by the use of bone wax.

Reflection of the bone flap may reveal bleeding bone margins or bleeding from dural vessels. Temporary control of the latter by small, wet cotton sponges and pressure will usually permit of the opening of the dura when they can be more safely controlled by suture or the use of wire clips. Prior to the opening of the dura the reduction of intracranial pressure is often necessary to prevent sudden herniation and brain contusion. This is readily accomplished in the presence of a hydrocephalus by ventricular puncture. Even in its absence, some fluid may be obtained by ventricular puncture or hypertonic intravenous solutions of glucose, or Ringer's solution may be used. Occasionally puncture of the opposite ventricle through a separate opening is necessary. In our experience the dura is best opened by a flap incision with the base of the flap toward the longitudinal sinus. This permits of easier closure in the face of considerable pressure. The site and character of the lesion with which we are dealing often make some other arrangement of the flap advisable.

For the control of cortical vessels about a tumor, ties with fine silk and silver clips are used. Hæmostats cannot be used and ties are passed beneath the vessels with a blunt pointed, fine, curved needle. During intracranial work and especially in surgery of the brain itself, irrigation with Ringer's solution at 40 degrees C. largely replaces sponging and serves to keep exposed surfaces from drying. Moist cotton is also used

for small pressure packs. No gauze or other rough contact is permitted. Suction apparatus to withdraw fluid from cavities and largely to replace sponging may be used with satisfaction. Small dural vessels may be controlled in the same manner or plastered with bits of muscle when tying or clipping is not feasible. For closure we believe that except over the area of a purposeful decompression, the dura should be closed. Areas of dural defect in the absence of cause for pressure may, however, be permitted in certain instances. In the presence of pressure, dural defects or dural and bone defects should not be left over the cerebral hemispheres except perhaps in a few instances of inoperable tumor already causing complete loss of function of that part of the brain.

For dural closure, as for closure of the deep scalp and skin, trials of many materials and many types of sutures have caused a return to the fine silk suture. Closely spaced sutures in the deep layer of the scalp best control bleeding. Ties of scalp vessels are rarely necessary and when used a suture is whipped about the vessel and then tied.

THE OCCIPITAL FLAP

The following procedure was first used in 1921 to gain access to an acoustic neuroma which had been found at an earlier suboccipital operation to lie too high in the angle for a satisfactory approach by that route. Since that time this operation has been used with increasing satisfaction for a wide variety of lesions.

The occipital flap provides a supratentorial approach to infratentorial lesions. With tumors and with impactions in the posterior fossa, it offers a method of intracranial decompression.

The occipital flap is placed with the hinge just above the mastoid and the posterior part of the temporal fossa. The anterior margin of the flap extends from the posterior part of the temporal fossa upward to the region of the longitudinal sinus and usually in front of the parietal eminence. The posterior margin is parallel to, and immediately above, the lateral sinus. The mesial margin of the flap is parallel to the longitudinal sinus and close to it. The patient is placed in the face down "cerebellar" position, the flap fashioned in the usual manner except that the hinge of the flap should be sawed as are the other margins. The thickness of the bone at the hinge is great enough to make the fracturing of it difficult and uncertain. With the dura exposed, ventricular puncture is performed and the ventricles well emptied. Nearly all of the lesions for which this operation is performed are associated with an internal hydrocephalus. The

Fig. 5.

emptying of the ventricle permits of easy elevation of the occipital lobe and wide exposure (Fig. 2).

The dura is opened usually with the hinge anteriorly. A varying number of veins will be found communicating with the lateral sinus from the margin of the occipital lobe. These are clipped or tied, and divided. From the dura over the petrous bone in the region of the internal ear, two or three veins from the temporal lobe may likewise need ligating. The occipital lobe, if the ventricles are well emptied, is then elevated with a broad, flat spatula or broad lighted retractor. The lifting of the occipital lobe upward exposes the tentorium, the attachment to the margin of the petrous bone, the floor of the middle fossa and far forward to the posterior clinoids. Retraction of the lobe laterally from the falx exposes all the posterior portion of the falx, the entire half of the tentorium and up to the corpus callosum, the pineal region, and the incisura tentorii. The sinus rectus, lateral and longitudinal sinuses are, of course, all visible. No other flaps in ordinary use give as wide a range of exposure as does the occipital flap.

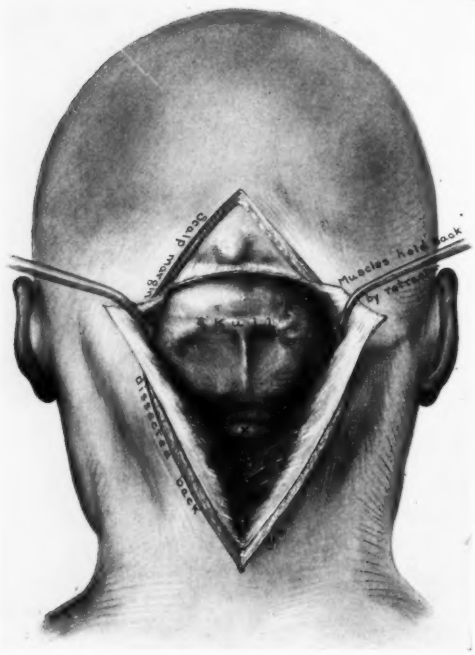

Fig. 6.

For approach to the infratentorial lesions, if pressure in the posterior fossa is high even after the reduction of supratentorial pressure by the ventricular puncture, a lumbar puncture may be performed.

Incision is made in the tentorium. Occasionally irregular venous sinuses may be seen in the tentorium but can be controlled. The incision in the tentorium is widened in all directions up to the petrous bone anteriorly, to the sinus rectus mesially, and to the lateral sinus. An occasional vein bridges between tentorium and cerebellum and requires clipping. With this opening the upper surface of the cerebellar lobe is exposed over a wide area (Fig. 3). Retraction of it backward and laterally gives an exposure of the angle and the pons. The seventh and eighth nerves are seen below and the fifth root toward the midline. Beneath the apex of the tent may be seen the opposite cerebellar lobe.

In the use of this method less dislocation of the cerebellar hemispheres and brain stem is required to secure a high approach to the angle. The pons may be seen and dissection conducted away from it rather than toward it as is the case from a crossbow incision.

With invading tumors, the large tentorial opening which is not closed permits an intracranial decompression of the posterior fossa with relief of the impaction so often seen. Following a suboccipital operation for an irremovable tumor, the internal hydrocephalus and increased pressure may persist due to unrelieved block. In such instances the tumor together with the other structures of the posterior fossa so fill the space that an impaction persists. Blockage of the fluid channels about the incisura tentorii—the peripontine pathway and the midsagittal cerebellar channel, or the posterior part of the intraventricular system, persists. Wide opening of the tentorium permits upward expansion of tumors, which otherwise press the cerebellum downward, and enlarges the subtentorial space. Protrusion or extension upward beneath the occipital lobe is accompanied by no symptoms and great expansion is permitted. With great dislocation of structures in the posterior fossa the incisura tentorii may be cut.

This has resulted in the relief of obstructive hydrocephalus when suboccipital decompressions have failed. At the conclusion of the operation the dura of the tentorium is left widely open. The dura over the vault is completely closed and the flap replaced.

MODIFICATIONS OF METHOD

In individuals who have previously been subjected to a suboccipital operation, the occipital flap may be modified. If there has been a suboccipital crossbow incision, one lateral half of the incision may be used to form the posterior margin of the occipital flap (Fig. 4). In such instances the scalp has been dissected downward sufficiently to expose the line of previous incision in the neck muscles just below the superior curved line. The muscles have been cut again along the line of previous incision. The occipital flap has been then formed to include all the bone down to the decompressed area. This involves removal of the bone overlying the lateral sinus, but this has proved to be surprisingly free from difficulty. The bone cuts are made in such a way that the flap cannot slide downward due to pull of the neck muscles after closure. In certain instances, to secure even greater freedom of exposure, the lateral sinus may be tied and divided. The cut may be carried on to the incisura, and the entire tentorium reflected. Inasmuch as the suboccipital operation has been previously performed the cerebellum is already decompressed and can be retracted posteriorly and downward much more readily.

Fig. 7.

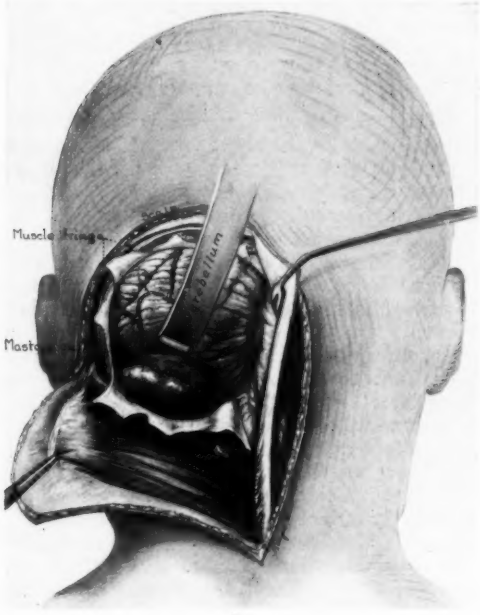

Fig. 8.

MODIFICATIONS OF SUBOCCIPITAL PROCEDURES

The crossbow incision of Cushing may, with certain lesions and depending upon the build of the individual patient, be modified to advantage. In the midline tumors of children, in intracerebellar tumors and especially in those adults with long necks, a midline incision has been used. In the presence of intracranial pressure the bleeding is lessened during the operative performance by an early reduction of pressure. With an internal hydrocephalus, early ventricular puncture through a separate small opening over the posterior horn of one lateral ventricle is helpful. This should be performed at the beginning of the operation. Pressure is at once reduced, bleeding lessened, and the presence of an internal hydrocephalus confirmed—the absence of which would indicate a probable diagnostic error and unnecessary suboccipital operation. Certain technical points should be observed to obtain the best exposure. The midline incision should extend from about 4 centimeters above the external occipital protuberance downward to the fifth cervical spine or lower and is carried through the scalp down to the deep fascia (Fig. 5). Wide dissection of this layer from the deep fascia is important, and the separation is carried well lateralward. The midline between the cervical muscles is split, retracted, and subperiosteal separation of muscles from the occipital bone is made. This is facilitated by the use of double-angled elevating retractors. The subperiosteal separation is carried from the muscle attachment at the superior curved line above to the mastoids laterally and temporary gauze packs introduced. After a similar separation on the opposite side the area of exposure is increased by cutting the deep fascia and muscular attachments to the right and left of the torcula for a distance of about 3 to 4 centimeters. A fringe of deep fascia and muscle is left for subsequent suture (Fig. 6). Contrary to the crossbow incision in which the occipital artery and great occipital nerves are divided, these structures can be spared. The nicking of the firm ligamentous attachments to the foramen magnum and the atlas, and the use of spring thyroid retractors give a wide exposure and permit the same bone removal, dural opening and opportunity for decompression, and the necessary intracranial work as the wider cross-

bow incision (Fig. 7). Closure, of course, is much simplified.

THE APPROACH TO TUMORS OF THE CEREBELLO-PONTILE ANGLE BY THE SUBOCCIPITAL ROUTE

With angle tumors, if approached from below, a combination of the above midline incision with a single half of the crossbow incision shortens the procedure considerably without sacrificing the advantages of the full crossbow (Fig. 8). The side opposite the lesion can be fully decompressed without wide incision of scalp and muscles. On the side of the lesion the curved incision should be carried out to the mastoid and down to or just below its tip. To obtain the full advantages of exposure, the scalp must be freely dissected well back from the deep fascia before cutting the muscular attachments at the curved line. The bone removal must extend fully to the lateral sinus above and laterally to and often into the mastoid cells. The bone removal below is carried well beneath the reflected muscles which are thoroughly retracted.

In the crossbow operation of Cushing, improper handling during and after operation may give rise to two difficulties. Impairment of circulation of the angles of the flaps is caused, first by too free use of hæmostats in this region throughout the operation; and second, by deep sutures of the scalp which include and constrict too much tissue and skin sutures which bear the same criticism. During the closure for a distance of 2 centimeters from the angles, fine skin sutures which take very small bites of the skin only, without subcutaneous tissue are sufficient to obtain accurate approximation. The full crossbow incision divides the entire occipital nerve supply, leaving the most prominent portion of the occiput anæsthetic. The risk of decubitus, if the weight of the head is allowed to rest indefinitely on this area, is obvious, particularly since its blood supply is somewhat lessened by the same incision. The proper filling up of the suboccipital hollow with an adequate amount of dressings will remove the possibility of too localized pressure and the unnecessary decubitus.

As in the surgery of other regions, a satisfactory exposure of the lesion is essential. For many of the lesions in the posterior fossa the crossbow incision of Cushing or some of the simplifications of it are satisfactory. For the approach to lesions high in the angle, it leaves much to be desired. The methods here presented have been found helpful. By means of the occipital flap a transtentorial approach can be made. It affords access to the upper and anterior surfaces of the cerebellum, to the fifth nerve, and other nerves of the angle. This is an ideal approach for lesions of the tentorium, the posterior half of the falx cerebri, the occipital lobe, the pons, and pineal region. Section of the tentorium and incisura tentorii affords a method of intracranial decompression. By means of it, hydrocephalus from impaction in the posterior fossa has been relieved when other measures have failed.

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FROM THE SURGICAL SERVICE OF RUDOLF HOSPITAL OF VIENNA

THE THORACOPLASTIC TREATMENT OF PULMONARY TUBERCULOSIS

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THE operative treatment of pulmonary tuberculosis not only is of advantage to the individual, but possesses great hygienic importance for society; because in the great majority of cases, it is possible to free the sputum of the patient from bacilli, and this eradicates one more source of infection in the patient's environment. The surgical treatment of pulmonary tuberculosis is, therefore, of no little importance and deserves to become better known.

If the outcome of operation is to be good, the indication for operation must be right. This, however, is a problem as difficult to solve as it is important. In principle, only unilateral cases are suitable for surgical treatment, if internal measures have proved fruitless or the financial status of the patient makes protracted conservative treatment impossible. Old, stationary, individual foci in the healthy lung form no absolute contra-indication, but one must make sure that such foci have no tendency to progression. In addition, the diseased lung must disclose a tendency to shrinkage (purely or predominantly productive or proliferative type of tuberculosis). Essentially exudative forms, which lead to rapid progression of the disease and cachexia, are much less suitable for surgical treatment since the chances for cure or considerable improvement are small and the mortality is great. The one other requirement for operation is the presence of pleural adhesions, since the presence of a normal pleural cavity demands the trial of an artificial pneumothorax. It is important to try such a pneumothorax before deciding upon operation. I have repeatedly observed that pneumothorax is still possible in cases in which the pleural cavity is apparently entirely destroyed. Only in exceptional cases should primary thoracoplasty be tried with the presence of a free pleural cavity. Aside from an extensive affection of the other lung, absolute contra-indications to thoracoplastic treatment are high fever, rapid progression of the case, lobar tuberculous pneumonia, decompensated cardial affection, tuberculosis of the intestines and kidneys, and multiple foci of the bones.

Partial thoracoplasty is indicated in cases of incomplete pneumothorax or as a complement to the non-collapsed part of the lung in the presence of a lung plug.

Of the various methods of operation in use I wish to discuss only that of thoracoplasty.

TECHNIQUE

Preparation of the patient. Every protracted case of pulmonary tuberculosis damages the heart because of toxic action, and the result is to be observed in tachycardia and an easily compressible pulse. Since thoracoplasty calls for reliable heart action because of the reduced pulmonary circulation on the side operated upon, it is necessary to carry out a preliminary treatment, if the heart is not in satisfactory condition. This is done by the administration of digitalis or cardiazol as well as by keeping the patient in bed. It is especially important to cleanse the affected pulmonary focus as well as possible by means of expectorants so that postoperative stasis of secretions and the danger of aspiration may be avioded. The intestine should also be cleansed in order to save the patient the strain of exhausting enemata following the operation. A half hour before operation, the patient receives 0.01 to 0.02 gram of morphine and ½ milligram of atropine hypodermically.

The position of the patient on the operating table is of especial importance. Inasmuch as the operation is, if possible, to be done under local anæsthesia, the patient should be placed as comfortably as possible. The back of the table is raised upright and a round pillow is placed in the lumbar region of the patient. In this way the spinal column of the patient is bent toward the healthy side, the affected side is maximally curved, the intercostal spaces broadened, and the operation thus considerably simplified. A pillow is also placed under the head of the patient after it has been bent forward. The arm of the healthy side should not be placed on the pillow under the head, but is held down, since otherwise quite unpleasant paræsthesia occurs (Fig. 1). An assistant extends the arm of the affected side maximally toward the front and downward, in order to draw the scapula away from the ribs. A pillow fastened close to the patient's pelvis on the table prevents the patient from slipping down. The patient's feet hang over the edge of the table, but they must be well supported by a chair. The assistant who pulls on the arm of the affected side simultane-

ously presses one fist into that axilla in order to prevent the patient from falling over forward.

Anæsthesia. A thoracoplastic operation can almost always be done under local anæsthesia, and only if the patient is very restless and nervous is it necessary to make use of a short and superficial ether narcosis. I consider that a general anæsthesia is detrimental, and I have never yet had to make use of one in these cases. The method of choice is conduction anæsthesia of the intercostal nerves. After the field of operation has been disinfected, 10 cubic centimeters of a ½ per cent solution of novocain or of a ¼ per cent solution of tutocaine are injected at the lower edge of the rib in question, about three fingers' breadths lateral to the medial line of the spinal processes. This injection is made on every rib to be resected, in addition to which the line of incision is infiltrated in all 3 layers: intracutaneous, subcutaneous, and intramuscular.

If the patient is lean, intercostal anæsthesia by this method is rather easy. If the patient is very muscular or fat it is often impossible to palpate the point of injection on each rib, and this is often impossible as far as the more proximal ribs are concerned as they are covered with thick layers of muscle. In such patients it is advisable to use some other method. One first anæsthetizes the line of incision, layer for layer, with the anæsthetic. Then each rib is exposed and the anæsthetic applied directly. One should not inject more than a total of 150 cubic centimeters of the anæsthetic. In 10 or 20 minutes the anæsthesia is complete. Should pain occur during the resection, it is necessary to apply a few more cubic centimeters of the anæsthetic by injection on the upper and lower edges of the rib in order to free the patient from pain. Superficial general narcosis was necessary in only the most exceptional cases.

Incision. Although the operation at one sitting is to be preferred to the thoracoplasty done in two or more sittings, the operation is, nevertheless, seldom possible at one sitting, since it is too great an ordeal for an organism damaged to such an extent. Operation at one sitting will therefore be an exception, to be carried out only in a very strong, afebrile patient whose heart is in absolutely good condition and in whom the tuberculosis has been of the purely productive form with a tendency to shrinkage.

Generally, the operation is carried out in two stages. In the first stage the eleventh to the sixth ribs are resected, in the second stage the fifth to the first. Resection should begin over the upper ribs only in the event of a tuberculous empyema which compresses the lower lobe of the lung. Figure 1 demonstrates the incisions for each stage. The lower plastic is begun with an incision at a level with the sixth rib, about 3 fingers' breadths lateral to the medial line of the spinal processes; the incision drops perpendicularly to the eleventh rib and then about a hand's breadth laterally along the eleventh rib. For the upper plastic, the incision begins at about 3 or 4 fingers' breadths under the shoulder, extends first between the medial spinal line and the medial scapular margin downward as far as the scapular angle, and then laterally until just under the latter. The incision should not reach the apex of the shoulder because this would cut muscle tissue unnecessarily and, in addition, provoke muscular atrophy by severing the branches of the transverse scapular artery. This result is not only disfiguring but also inhibits the function of the arm. An arch-like incision around the scapula easily permits the latter to be lifted away from the thorax, thus offering a broader approach to the ribs just under it.

The incision should penetrate the skin, the subcutaneous tissues, and also all the muscles as far as the ribs in the same direction. The soft flap thus formed is pulled away laterally as far as possible from the bones of the thorax. This is of especial importance in the scapular region. The long muscles of the back are separated from the bones and drawn toward the spine, thus exposing those portions of the ribs between the costal angles and the lateral spinal processes. It is usually possible to secure hæmostasis in this part by suitable compression. It is very important to treat these long muscles with consideration, since they are the foundation of the upright posture of the spinal column and any considerable damage of them will enhance the tendency to scoliosis following thoracoplastic. Now the ribs are free for resection. The periosteum in the middle of the ribs is first split and then with the rasp pushed away toward both edges. In order to expose the anterior surface of the ribs, the edges must be absolutely free from periosteum. This is best insured by using the rasp from median line outward on the upper edge and from the side toward the inside on the lower edge (i.e. against the direction of the fibers of the intercostal muscles, Fig. 2). As soon as the posterior surface of the rib has been exposed, the detachment of the periosteum from the anterior surface is carried out by means of a curved rasp (Fig. 3).

The effect of the operation is considerably improved if the ribs are extensively resected. The greater the destruction within the lung, the greater must be the extent of the resection and the collapse effect. The length of the pieces resected

Fig. 1. Showing position of the patient on the operating table and incision lines for first (a) and second (b) stages.

determines the degree of collapse. In general, 10 to 15 centimeters are resected from the lower ribs, 10 to 12 centimeters from the middle ones, and 4 to 10 centimeters from the upper ones. In principle, the resection should approach the spinal column as closely as possible and it is of particular importance to pay close attention to just this point during resection, as one is otherwise surprised at the length of the stumps remaining. If the stumps are too long, the collapse effect is usually too small, and it is sometimes necessary to reduce the length of the stumps as far as the lateral processes of the spine by means of bone forceps.

The resection of the 5 upper ribs demands individual attention (second stage). Under normal circumstances, with the scapula in position, these ribs are covered by the scapula. Now, the successful collapse of the proximal ribs is of great importance because the upper lobe is usually most deeply affected, and it is, therefore, very necessary that precisely these ribs be extensively resected. In order to make this possible, the scapula must be retracted energetically by an assistant by means of 2 retractors (Fig. 3), this being possible

Fig. 2. The use of the rasp from the side (right) toward the spine on the lower edge, and from the spine to the side (left) for the upper edge to free the rib of periosteum.

because of the arch incision mentioned above. In this way it is possible to resect pieces as long as 10 to 12 centimeters even in the upper ribs. The decisions as to whether larger or smaller pieces should be resected depends upon the extent and advance of the pulmonary destruction.

The most difficult part of thoracoplasty is the resection of the first rib. The resection of this rib is absolutely necessary in every case. The approach is made suitably free by firm upward retraction of the soft parts (Fig. 3). It is always necessary to take every precaution that the rib considered as the first is really the first, otherwise it is quite possible that the rib can be overlooked. This rib can be recognized by the fact that the surfaces are horizontally placed, facing up and down instead of forward and backward. Since the first rib is considerably shorter than the others, it is sufficient for our purposes if we resect only 3 to 4 centimeters from it. As it is particularly difficult to resect part of this first rib, special instruments are necessary, the best of these being the rasp and rib scissors recommended by Sauerbruch.

Just above the first rib the brachial plexus and the subclavian artery and vein pass by. In the event that resection is not executed with caution, these structures can be damaged, with the rasp as well as with the rib shears. Reports of such cases have been published. The injury to the subclavian vein may lead either to fatal hæmorrhage or to air embolus and must therefore be avoided under all circumstances. But there are also secondary

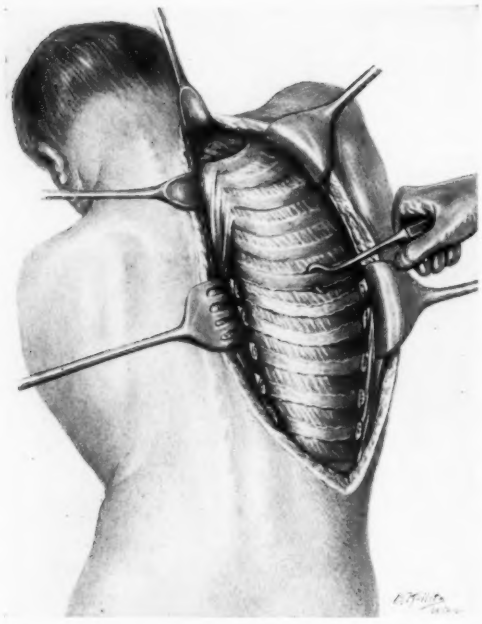

Fig. 3. A curved rasp is used to free inner surface of ribs of periosteum.

injuries to these structures such as those due to the presence of sharp edges or ends to the rib stumps. It is, therefore, necessary to smooth these as well as possible by means of the rib forceps.

After the operation has been completed (first and second stages), there follows exact and careful treatment of the wound. All the loose and bruised pieces of muscle which are damaged in their nutrition are excised; the large wound cavity should be douched with sterile salt solution in order that any possible bone particles may be washed away. Then the suture is carefully executed. For this purpose the shoulder is pushed backward and the edges of the wound brought closer together. The muscle suture is done carefully with the catgut-button type (1 row in the first stage in the lower portion of the thorax and 2 rows in the second stage in the upper portion of the thorax). I usually put a rubber drain into the large wound cavity after the first stage or in one stage operations and leave it in for 24 hours under the musculature (Fig. 4). Following the second stage, the wound cavity is usually smaller and need not, therefore, be drained. Finally, the skin incision is sutured by means of loosely arranged silk-button sutures.

As a rule, patients tolerate the operation rather well. It is absolutely necessary, however, that a physician observe the pulse and the breathing during the entire course of the operation. It is also almost always necessary to administer a cardiac stimulant in the form of camphor or caffein during the operation. I also prefer to have the patients drink some hot, black coffee or some cognac during an operation which is executed under local anæsthesia. Cyanosis is not infrequent during the operation for the patients lie on the healthy lung which is thus inhibited in its breathing excursions. This is of no particular importance as long as the breathing is regular, but as soon as marked dyspnœa appears, the operation should be immediately interrupted and improvement of the patient attempted by means of supine position, oxygen breathing, and application of stimulants. It is sometimes advisable to do the operation in 3 stages in case of very weak patients.

Sometimes a tachycardia occurs after the patient has already been placed on the operating table, and this may reach 150 beats to the minute. In such cases it is best to wait until the pulse has settled or to give stimulants (cardiazol, camphor, digipuratum); in the majority of cases it is possible to continue as the pulse will drop in rate and the patient become quieter. The tachycardia may be due partly to psychic excitement, but if the increased rate persists despite all measures, the operation should not be carried out. In one of my patients we were able to operate successfully only after 3 attempts of this kind.

Dressing. I always avoid any possible compression of the wound in dressing, since this annoys the patients greatly and disturbs breathing. The dressing should be very loose, and I always bandage over an assistant's fist, placed against the lower part of the sternum during the process. This prevents too tight a bandage. Supine position of the patient is sufficient security for the compression of the wound. This is also the reason why I avoid the non-support position of the back. The back should lie on a support, and if the bandage is stuck with mastisol or the like, it will not be displaced despite its looseness. I do not use the compression pillows recommended by Sauerbruch which are attached to the thorax by means of rubber bands, nor have I felt the need to use them.

AFTER-TREATMENT

Almost upright, supine position of the patient, position of the arm of the side operated upon, on a pillow, all increase the comfort of the patient after operation. It is sometimes necessary to apply oxygen for breathing. It is especially

important to use plenty of morphine or pantopon during the first week following operation. The patients then cough more easily. The sputum is usually reduced during the first 2 days following operation, then it becomes even more copious than before operation, but is soon reduced again in quantity. The nurses should be instructed to support the movable side of the thorax every time the patient coughs, and after a few days the patient can do this himself. It is important that the patients cough energetically and completely; otherwise aspiration into the healthy lung is easy and this complication is always very serious. In addition to morphine and pantopon, cardiac stimulants must be administered plentifully during the first few days following operation. I consider the use of antipyretics of no great necessity even if the temperature rises considerably the first few days after operation, as is often the case. After a few days the temperature of itself usually drops to normal.

The interval between the first and the second stage is 2 weeks, if healing and general condition are good. In the event that healing of the wound is disturbed or the general condition too weak, the interval must be suitably longer. The earlier the second stage is executed, the better and more complete is the collapse. After the wound of the second operation has healed completely and the patient has regained sufficient strength, he must be transferred to a suitable sanatorium for a period of from 4 to 6 months.

COMPLICATIONS

It is possible that, during the process of extracting a rib, one may injure the pleura if the pleural cavity is not completely obliterated. The result is a pneumothorax which, if it is sacculated, is of no importance. Threatening conditions occur only if the pleura is completely free and the injury leads to mediastinal displacement due to total pneumothorax. In such cases super-atmospheric breathing must be applied and the pleural wound sutured air-tight immediately. If only a partial pneumothorax occurs, the operation can be continued. In case of total pneumothorax due to injury of the pleura the operation is interrupted and the pneumothorax left alone. These possible accidents show how important it is to try an artificial pneumothorax before operating.

Another complication is the disturbances in wound healing which occur more frequently if the soft parts have become thickened by lymph stasis before operation. Sorgo, in Vienna, emphasized the dangers of this complication. In such cases, the pleura also discloses a jellied appearance. Wound

Fig. 4. Closure of wound and drainage tube in place.

healing can take a disturbed course also in case of purulent pleural effusions, and the protracted course can finally be provoked by infection during operation, a circumstance which is not at all impossible considering the size of the wound cavity.

Complications may also arise in the heart and in the other lung during the postoperative course. The latter are especially serious. These complications are either the exacerbation of latent foci or the result of aspirations of sputum containing bacilli in the course of incomplete expectoration and coughing. The pneumonia which may occur at the end of the first or the beginning of the second week after operation is usually fatal.

RESULTS

The effect of thoracoplastic operations depends upon the proliferating component of the process. In the essentially proliferating (productive) types, the immediate mortality after thoracoplasty was 3 to 4 per cent; early and tardy fatalities together made up about 10 per cent. Permanent cure and considerable improvement with freedom from bacilli was 70 to 75 per cent. The sputum is free from bacilli a few weeks after operation in some cases. The more the exudative component present, the

worse are results. In these forms the immediate mortality is 25 per cent, the early and tardy fatalities together over 50 per cent. The chances for improvement are not more than 25 to 30 per cent, and in patients over 50 years are even less.

In the event that the operative result is not satisfactory and the process is still unilateral, the effect can be improved by re-operation. This may consist in renewed resection paravertebrally of the upper ribs or anterior, parasternal operation. If the cavity is near the anterior wall, the resection of the anterior rib portions (1 to 4 or 5) leads to better results. Secondary pneumolysis and plugging with paraffin can be carried out, but these are usually difficult because of induration. Phrenicotomy is also possible. This operation I rarely perform before a plastic operation and then only as a test operation. Otherwise I reserve it for repeated pulmonary hæmorrhages. Even in very obstinate cases, I have repeatedly been able to secure cure or freedom from bacilli by means of one or more operations.

BLASTOMYCOSIS OF THE ŒSOPHAGUS[1]

Report of a Case

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BLASTOMYCOSIS of the skin with generalized dissemination of the disease is no longer considered rare. Many such cases have been reported by Montgomery and Ormsby, Stober, and Wade and Bel, the last observers having reviewed the postmortem data in 47 cases.

It is of interest that the œsophagus was involved once only in this series of cases. The patient was observed by Shepherd and Rhea, and succumbed to generalized blastomycotic infection. At the postmortem examination, a fluctuating area 1 centimeter in diameter was found 7 centimeters above the cardia. Every organ of the body was involved in the process except the brain. The patient did not have symptoms referable to the œsophagus.

New reported a case of primary blastomycosis of the tongue without dissemination; and Jackson, Dennis, and Downing have each observed a case of primary blastomycosis of the larynx; but we have been unable to find reference to any case in the literature in which the disease was primarily in the œsophagus. We are, therefore, reporting a case recently observed in the Mayo Clinic.

A man, aged 41 years, who had resided in Chicago for a number of years, was examined April 11, 1927. Twelve years previously he had had pulmonary tuberculosis and bacilli of tuberculosis were found in the sputum. After a period of 4 months in a sanatorium, there followed a period of excellent health for 11 years. During this time the patient had followed a strict hygienic regimen, sleeping on a porch at night. His work as an accountant was done in comfortable surroundings. Nine months previous to examination at the Mayo Clinic, he noticed obstruction in the upper portion of the œsophagus to the passage of solid food. This had progressed slowly to the point where soft foods were taken with little difficulty. Œsophagoscopic

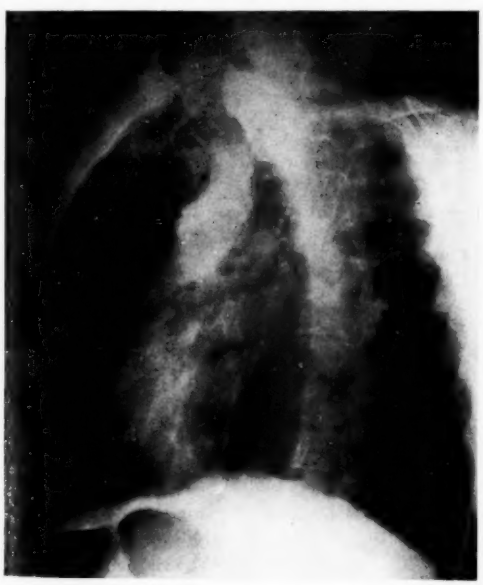

Fig. 1. Stricture of the upper third of the œsophagus from blastomycosis.

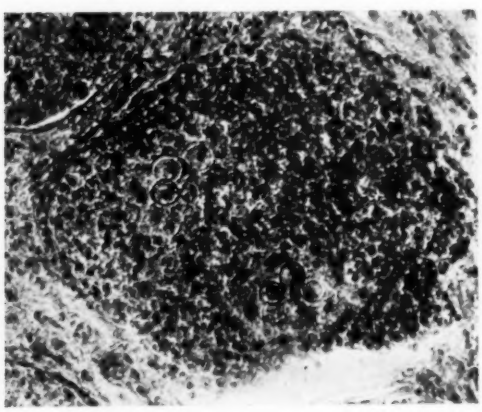

Fig. 2. Tissue from blastomycotic granuloma showing budding organisms.

[1] Submitted for publication August 15, 1927.

examination elsewhere had revealed a mass in the upper part of the œsophagus, but a definite diagnosis had not been made.

General examination revealed infiltration in the upper lobe of the right lung, and roentgenographic examination of the chest revealed bilateral tuberculosis with multiple cavitations. Bacilli of tuberculosis were found in the sputum on two occasions. Roentgenographic examination of the œsophagus showed a smooth obstruction in the upper portion of the organ which was thought to be due to benign stricture (Fig. 1). Œsophagoscopic examination disclosed an annular funnel-shaped lesion which was granular and soft; the lumen of the stricture was about 4 millimeters in diameter. A specimen removed for microscopic examination proved to be part of a blastomycotic granuloma (Fig. 2). The sputum was then repeatedly examined for blastomycetes but none was found.

Iodides were given by mouth, and, at the suggestion of Dudley Smith of the University of Virginia, gentian violet by mouth and intravenously was also employed. June 11, because of marked œsophageal obstruction, it was found necessary to dilate the stricture, using a 25 French sound. This afforded considerable relief from dysphagia.

The patient is still under observation, and the ultimate result of treatment is still uncertain.

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STABILIZATION OF THE SHOULDER JOINT FOR HABITUAL DISLOCATION[1]

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THE shoulder joint is frequently the site of habitual dislocations which cause disturbances of function. Even if the recurrence does not produce such violent reactions as the primary dislocation produces, nevertheless the uncertainty and the anxiety that redislocation may occur cause interference with working efficiency. Because the joint is relaxed, the least movement of the arm backward, either by elevation or by the supporting of the arms in a backward position, causes redislocation of the shoulder joint (forward anteriorly).

Fig. 1. Technique of the operation.

All of the well known methods of rehabilitating the joint have some weak point. Capsulorrhaphy alone is seldom satisfactory. By the complicated muscle plastics of Clairmont and Finsterer, some degree of fixation may easily be secured with impairment of motion in the shoulder joint. Considered from the point of view of redislocation, this is an advantage; but from that of working capacity, it is not so valuable.

Therefore another method was devised for fixation of the arm to the acromion, the transfixation of fascial straps. By this method the range of motion of the shoulder joint is preserved and at the same time the chances of redislocation are reduced to a minimum. The method is as follows:

With a curved incision the insertion of the deltoid muscle is exposed. The muscle is separated from its insertion, and the main flap retracted upward. If it is carefully borne in mind that the distribution of the axillary nerve is in the back part of the flap, injury to it can easily be prevented. After the capsule has been exposed, a silk ligature, double four-ply strong (Turnersilk), is passed

[1] Translated by L. L. Roth, M.D., New York City.

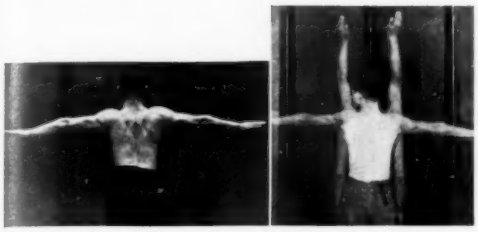

Fig. 2.

with a specially bent elevator perforated at the end, around the surgical neck of the humerus, and a double knot is made on the anterior side over the joint. We therefore have four strong silk ligatures parallel to each other on the anterior surface of the joint. These are transfixed and well knotted to the coracoid process which is well exposed. The origin of the biceps muscle which is on this process prevents the slipping of the ligatures. The four threads form a strong band lying on the anterior surface of the joint. The capsule on both sides of this band is now lifted and the folds are sutured around the silk band. Therefore the sheath in which the silk band now lies is exactly similar to that of the tendon of the long head of the biceps muscle passing the shoulder joint.

We have therefore at this point, which is the weakest point, an artificial reinforcement of the capsule and also a shortening of the joint capsule space which we have gained by the folding over.

It should be explained that the silk thread which we use has a tensile strength of 40 kilograms (86 pounds), so that with one ligature we have a resistance of 80 kilograms and with the entire band a resistance of about 160 kilograms.

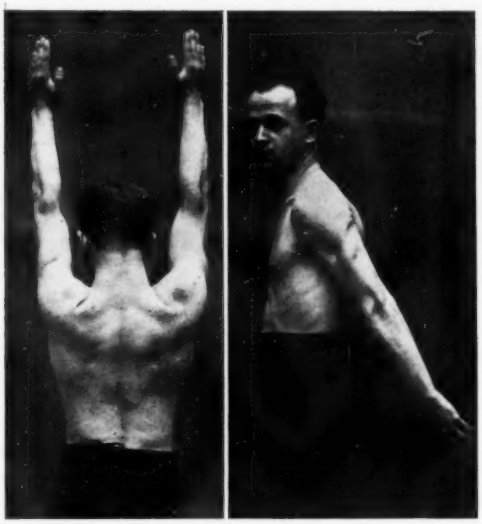

Fig. 2. Before the operation, dislocation occurred as much as 20 times a week. Since the operation (1924) dislocation has not occurred once. The pictures show the normal amount of motion after operation.

The flap is now replaced and with perosseous sutures the deltoid tendon is fastened at the place of its insertion on the humerus.

After a period of rest of 4 weeks, the patient begins careful exercises.

In the cases operated upon by this method, the patients recovered complete working capacity and regained free motion in the joint. Dislocation, which had been common at short intervals, never recurred.

A SIMPLE METHOD OF REMOVING THE CERVIX WITH THE UTERUS IN HYSTERECTOMY

By FRANK H. LAHEY, M.D., F.A.C.S., Boston

IN July, 1923,[1] we published a description of a method of excising the major portion of the cervix with all of the cervical canal in hysterectomy for benign lesions. On account of the good results following its use in several cases we recommended its employment because it had resulted in the desirable accomplishment of excising practically the entire cervix together with the uterus, without added danger to the ureters, with but slight added difficulty to the operation, without shortening the vagina during the period of sexual activity, and with preservation of the cervical shell into which the broad and round ligaments are inserted, thus preserving a valuable structure for the support of the vagina and bladder. Further employment of this procedure in the clinic has not lessened our satisfaction with it. We have now employed this technique in 122 hysterectomies with complete satisfaction and

[1] Intracervical Enucleation. Ann. Surg., 1923, July.

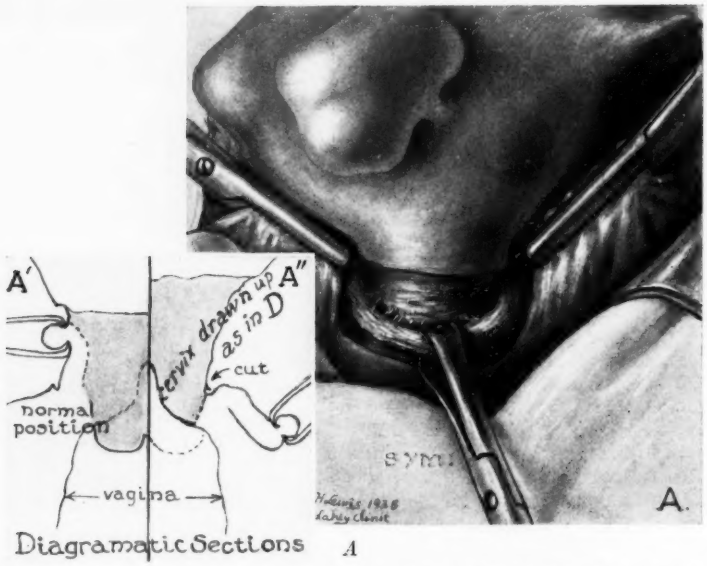

Fig. A. The uterine arteries have been clamped, the shallow incision in the cervix made around that structure and grasped with double hooks. The insert *A'* demonstrates diagrammatically the scheme of excising the cervix. On one side, the incision has been made in the cervix of sufficient depth to make the cervical shell which is to remain. Eversion of the shell has but just been begun. The shaded area represents the portion of the cervix which is to be removed, the light area represents the shell of the cervix which is to be rolled downward. On the other side of the insert *A''*, the uterus has been pulled upward and the shell of cervix dissected free, rolled downward, and everted.

again wish to direct attention to its value, as well as to add a few technical steps developed after further experience which make the operation easier.

Transcervical removal of the cervix should be undertaken only in those cases in which an adequate exposure of the cervix and pelvic fossa can be obtained. This will be possible in practically all cases except those in which the size of the uterine tumor, together with inability to deliver it, will prevent satisfactory demonstration of the complete circumference of the cervix down to its attachment to the vagina. In cases presenting difficulty in exposure, a simple transverse incision of the cervix with no attempt at cervical removal will be safer and more satisfactory.

As stated in the original description of this operation, bleeding and oozing during the excision of the cervix is considerably greater than during the simple supracervical hysterectomy and is the greatest drawback to the operation. At no time, however, has bleeding been uncontrollable or excessive in our hands. It has been bothersome only in that it lessens the neatness of the appearance of the operative field. While the neck of the uterus is being excised from its cervical shell, the oozing is considerable, but is immediately controlled as soon as the vaginal supports are sutured into the cervical shell. By the introduction of the corner of a folded towel into the fossa of Douglas, we have succeeded in catching the small amount of blood which comes from this oozing, so that after the mattress suture in the cervical shell is inserted, the suture of the cervix completed and bleeding controlled, the towel with any small accumulation of blood clots on it may be lifted out of the pelvis.

The particular point which we wish to demonstrate is the application of double hooks, such as we have employed in goiter surgery, to the front and back of the thin shell of cervical tissue which is to be left behind, so that with one assistant pulling up on the uterus and the other pressing the anterior and posterior double hook downward, the shell of cervix which is to remain may be gradually everted as the excision of the cervix is

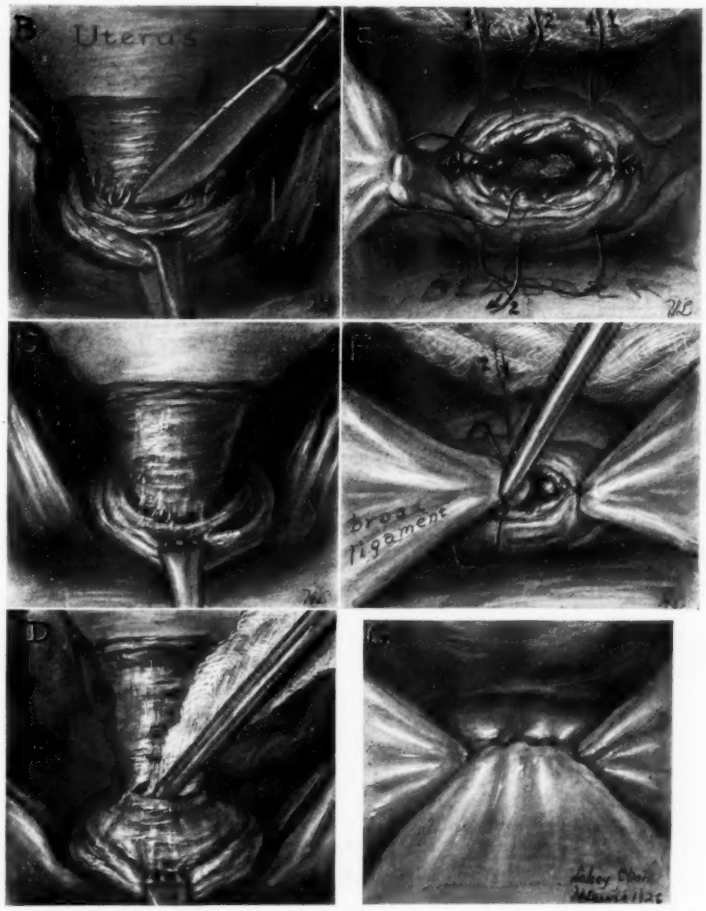

Fig. B. The anterior double hook only is shown, attached to the shell of cervical tissue, which is being pushed downward as the uterus is pulled upward and the dissection of the cervix continued.

Fig. C. The same further advanced, showing the fold which develops between the cervical shell and the cervix and in which the dissection should be carried out.

Fig. D. The cervix completely dissected, the opening into the vagina made on the anterior wall, and the thin strip of gauze being passed through it into the vagina. As soon as all of the gauze has been passed into the vagina so that no vaginal secretions may flow back up into the peritoneal cavity, the cervix is completely detached from its vaginal attachments.

Fig. E. The cervical remnant seen from above. The everted shell has been inverted and the gauze strip in the vagina may be seen. The mattress suture *1–1* is shown grasping the entire cervical shell and introduced low down, the bladder having been wiped off in front. This stitch must be accurately introduced, as it is the stitch which prevents postoperative bleeding into the vagina.

Fig. F. The broad and round ligaments separately or together may be introduced and sutured deeply in the shell. The mattress suture should be tied last, after introduction of the ligaments into the cervical pocket and closure of the cervix.

Fig. G. The usual peritonealization of the stump.

carried down to its vaginal attachment, just as a finger is extracted from a finger-cot by grasping the base of the cot and pulling the finger out of it.

The technical steps of the operation may be grasped from the Figures 1 to 7 with the attached legends.

The introducing into the vagina of a strip of gauze which has been unfolded and pulled out into a narrow ribbon is of advantage in keeping the secretions of the previously painted vagina out of the cervical shell and providing a small pack at the vaginal orifice of the cervical shell to control any small oozing not taken care of by the cervical sutures and mattress stitch.

In describing any operative plan which differs from those commonly employed, it should be the duty of the describer to set down any complications which have arisen in its use. Therefore, it is only fair to say that in 6 of the first 20 cases in which this scheme of cervical removal was employed, there was so much uncontrolled oozing into the vagina from the canal of the cervical shell that re-etherization and suture of the lower end of the cervical shell through the vagina was necessary.

Since the early cases, however, since we now wipe the bladder well off the anterior surface of the cervical shell and upper vaginal wall, so that the mattress stitch for control of oozing may be placed low in the cervix close to its attachment to the vagina, no further difficulty of this nature has arisen, and vaginal suture of the cervix has never been necessary.

From our experience with the procedure, we know of no drawback to its use and recommend its employment in all patients upon whom hysterectomy is performed for a benign lesion in which adequate exposure of the cervix may be obtained.

SURGICAL PROCEDURE IN OBLITERATIVE VASCULAR DISEASE (THROMBO-ANGIITIS OBLITERANS)

A Report of Forty-Five Cases[1]

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OBLITERATING thrombo-angiitis (Buerger's disease) usually affects males between the ages of 17 and 40 years. Juvenile and presenile gangrene have been used to designate the obliterative vascular lesion occurring chiefly in the extremities, which is now known as thrombo-angiitis obliterans. Buerger first described the condition as a definite pathological entity and clearly demonstrated the essential differences between this condition and arteriosclerotic disease of the extremities.

Excessive fatigue of the extremities or claudication pain brought on by exercise and relieved by rest is experienced early, and is manifested by pain in the calf, hand, arch, or single digits. Soon after, or coincident with the color changes, there is a continuous burning or aching pain largely limited to the digits, not related to exercise and partially relieved by the dependent position and heat. With the occurrence of marked trophic changes such as non-healing incisions or gangrene, this pain becomes sharp, is unrelieved by usual measures, and frequently is unbearable, requiring amputation for relief.

Objectively the earliest manifestation is the bluish-red discoloration of the digits increased by the dependent position and minimized by elevation (Fig. 1). The extremities are cold, and there are diminished or absent pulsation of the arteries, and mild trophic changes such as abnormal calluses and linear breaks in the skin. Later dry gangrene may occur spontaneously, but is more often incited by trauma, incision, or infection. In approximately 95 per cent of the cases, the complaint is referable chiefly to the lower extremities. In 30 per cent, there is some degree of arterial obliteration in the upper extremities. Symptoms are rarely referable to this region. Pathologically the process is an inflammation affecting primarily the main arteries and veins of the extremities. An obturating thrombus occurs which successively undergoes organization and fibrosis (Fig. 2). The

[1] Submitted for publication May 18, 1927.

Fig. 1. Foot in a case of thrombo-angiitis obliterans. In the dependent position there is bluish-red discoloration of the toes and distal part of the foot. The fourth toe is gangrenous and there is impending gangrene of the great toe. A small area of superficial phlebitis is present above the second and third toes.

end-stage is an organized thrombus in which new vascular channels occur. These are at first discrete; later they are fused into larger channels. Perivascular fibrosis binds together the nerve, artery, and vein.

CASES STUDIED

In approximately 80 per cent of the 100 cases in this series, a diagnosis had not been made, or it had been made incorrectly previous to the patient's admittance to the Mayo Clinic. In the stage of the disease when the toes become red and painful, and with symptoms and signs indicating an insufficient blood supply, incisions for "deep-seated infection" or removal of "ingrown toe nails" are frequently carried out. Gangrene is initiated by this procedure in 35 per cent of the cases. This is significant since the outlook for eventual recovery is greatly lessened in the presence of gangrene or non-healing incisions. Toes are amputated in cases in which there is obstruction of the proximal vessels, and if the blood supply is inadequate. Nonhealing of the incision, followed by gangrene, is the result. Amputation is frequently performed above the knee without sufficient consideration of the necessity of a functioning knee-joint. This is important in thrombo-angiitis obliterans, which occurs usually among young persons dependent for a livelihood on the maintenance of function in the lower extremities. Amputation below the knee may be unsuccessful, but usually because valuable methods which may be easily utilized, and which increase the possibility of primary healing, are neglected.

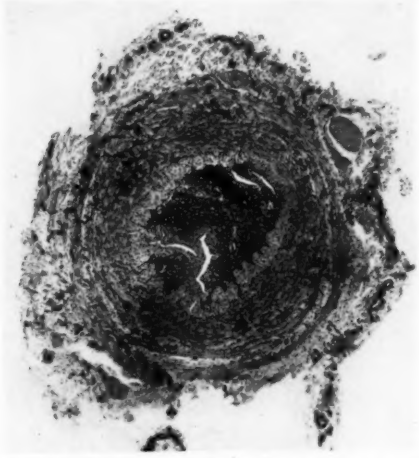

Fig. 2. An artery in a case of thrombo-angiitis obliterans. The lumen is occluded by an organized thrombus in which new channels have formed. There is lymphocytic infiltration of the arterial wall and surrounding tissue and many newly formed vessels in the peri-arterial tissue.

It is our purpose here to analyze carefully these surgical procedures. In a group of 150 cases of thrombo-angiitis obliterans observed in the years 1923–1926, surgical procedures were carried out in 45 cases at the Mayo Clinic or elsewhere. These 45 cases form the basis of this report. In all instances the term "successful" refers to healing by primary intention. "Prolonged healing" refers to healing prolonged for 2 months or more and "unhealing" refers to the condition at the time of observation or at the time of latest information.

SURGICAL PROCEDURES

The surgical procedures of incision or amputation in thrombo-angiitis obliterans can be conveniently grouped as: (1) incision of toes or removal of toe nails, (2) amputation of toes, (3) amputation below the knee, and (4) amputation above the knee.

Fig. 3.

Fig. 3. Foot in a case of successful amputation of the toes in thrombo-angiitis obliterans with thrombosis of the vessels of the toes. Note normal appearance of remaining toes and skin of foot. The vessels pulsated normally.

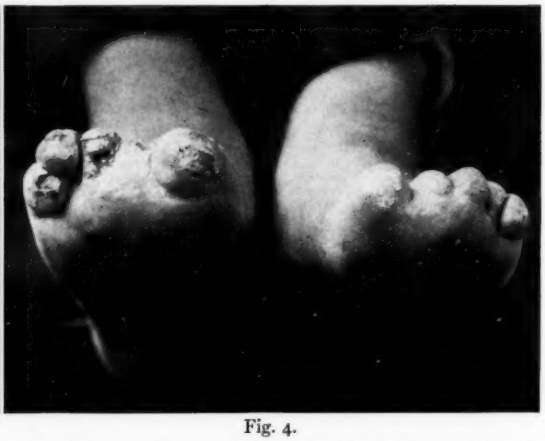

Fig. 4.

Fig. 4. Auto-amputation in a case of thrombo-angiitis obliterans. The amputation had been progressive over a 16-year period, during which time the patient was not disabled.

Incision of toes or removal of toe nails. In 15 cases the incision of toes or removal of toe nails (elsewhere) was successful in only 1 case (Table I), in which higher amputation was later required for a similar condition in other toes. In 1 case of prolonged healing, higher amputation was performed later. In 13 cases in which incisions did not heal, higher amputation was required in 9. In the remaining 4 cases, the incisions had not healed at last reports, and there is a probability that higher amputation will be necessary.

Amputation of toes. Toes were amputated in 6 cases at the Mayo Clinic (Table II). The operation was successful in 4 cases. Incisions did not heal in 2 cases, in both of which higher amputation was required later. Amputation was carried out in these 2 cases at the insistence of the patients. In 25 cases, 1 or more toes were amputated elsewhere. In 5 of these, healing was prompt, but in 1, amputation at a higher level was later required. In 10 cases, healing was prolonged, in 3 of which amputation at a higher level was necessary. In 9 of the cases in which amputation was done elsewhere, the incision failed to heal and higher amputation was later necessary in 7. The probability of higher amputation at a later date, in the 9 cases in which healing was designated as prolonged or absent, must be considered. Of the 31 cases in which amputation was performed at the Mayo Clinic and elsewhere, healing by primary intention occurred in 9. In 3 of these in which amputation was done elsewhere, the available data are not sufficient for consideration. In 3 of the 6 remaining cases sudden thrombosis occurred in 1 or 2 toes, and in 2 of these the vessels of the feet pulsated normally. In the 3 other cases, pulsations were normal in either the dorsalis pedis or posterior tibial vessels. In the successful cases, the average pulsation in the dorsalis pedis vessels was 1 and in the posterior tibial 1 to 2 (on a scale of 0 to 4). In the unsuccessful cases, the average

TABLE I.—RESULTS OF INCISION OF TOES OR REMOVAL OF TOE NAILS IN FIFTEEN CASES (OPERATION ELSEWHERE)

	Cases
Successful: requiring higher amputation	1
Prolonged healing: requiring higher amputation	1
Unhealed: requiring higher amputation	9
not requiring higher amputation	4

TABLE II.—RESULTS OF AMPUTATION OF TOES IN THIRTY-ONE CASES (SIX OPERATIONS IN MAYO CLINIC AND TWENTY-FIVE ELSEWHERE)

Mayo Clinic	Cases
Successful: not requiring higher amputation	4
Unhealed: requiring higher amputation	2
Elsewhere	
Successful: requiring higher amputation	1
not requiring higher amputation	4
Prolonged healing: requiring higher amputation	3
not requiring higher amputation	7
Unhealed: requiring higher amputation	7
not requiring higher amputation	2

TABLE III.—RESULTS OF AMPUTATION BELOW THE KNEE IN TWENTY-ONE CASES (TWELVE OPERATIONS IN MAYO CLINIC AND NINE ELSEWHERE)

Mayo Clinic	Cases
Successful: not requiring higher amputation	9
Prolonged: not requiring higher amputation	1
Unhealed: requiring higher amputation	2
Elsewhere	
Successful: not requiring higher amputation	6
Prolonged: not requiring higher amputation	1
Unhealed: requiring higher amputation	1
not requiring higher amputation	1

pulsation in the dorsalis pedis vessels was 0 to 1 and in the posterior tibial 0.

Amputation below the knee. Amputation was performed below the knee in 12 cases at the Mayo Clinic (Table III). Healing occurred by primary intention in 9 cases; it was prolonged in 1 and absent in 2. Accessory measures to stimulate healing were not carried out in either of these 2 cases, both of which required higher amputation later. In 9 cases, amputation below the knee was performed elsewhere; in 6 healing was prompt, in 1 it was prolonged, and in 2 it was absent. In 1 of the latter, amputation at a higher level was necessary later. In the total of 21 cases, healing by primary intention occurred in 15 cases (71 per cent) and was delayed in 10 per cent. In only 4 cases (19 per cent) was there failure to heal. A comparison of the successful and unsuccessful cases shows only insignificant variations in average age, average amount of rubor with the foot dependent, average amount of pallor with the foot elevated, and in the average severity of the rest pain. In the unsuccessful cases the average duration of symptoms was 6 years, twice that in the successful cases. Pulsation in the popliteal, dorsalis pedis, and posterior tibial vessels was always absent in the unsuccessful cases, but sometimes present in the successful cases. Pulsation, however, was absent in the popliteal artery in some cases in which amputation below the knee was successful.

Amputation above the knee. This operation was performed at the Mayo Clinic in 7 cases (Table IV). In 6 of these, healing was prompt, and in 1 it was prolonged. In 1 case high amputation was performed because of extensive gangrene of the foot and deep gangrenous ulcers over the tibia and knee, in 1 it was performed because of previous unsuccessful amputation below the knee, in 1 because of previous unsuccessful amputation of the toes, and in 1 because the patient was admitted with extensive gangrene of the foot and was extremely toxic because of absorption from the gangrenous area. In the 3 remaining cases, amputation was performed above the knee at a time when high amputations were thought necessary. Amputation above the knee was performed elsewhere in 9 cases, in 8 of which healing was prompt; it was prolonged in 1 case.

TABLE IV.—RESULTS OF AMPUTATION ABOVE THE KNEE IN SIXTEEN CASES (SEVEN OPERATIONS IN MAYO CLINIC AND NINE ELSEWHERE)

Mayo Clinic	Cases
Healed: not requiring higher amputation	6
Prolonged: not requiring higher amputation	1
Elsewhere	
Healed: not requiring higher amputation	8
Unhealed: not requiring higher amputation	1

DISCUSSION

The indications for amputation are not clearly defined in cases of thrombo-angiitis obliterans. Careful observation of such cases has shown that function in the diseased extremity is re-established in many cases by medical treatment. This is true in cases of gangrenous ulcer which heals spontaneously, or in cases of gangrene in which auto-amputation occurs. Mills states that auto-amputation of the toes frequently occurs in the stoic Chinaman, and function in the foot remains. Several cases of this type have been observed at the Mayo Clinic (Fig. 3).

The economic factor in cases of thrombo-angiitis obliterans cannot be overlooked. The disease usually occurs in patients with limited finances. Whether it is better to treat a patient medically over a period of months or years, with almost complete disability during this time, and with uncertain results, or to proceed with more radical treatment with the hope of a shorter period of economic loss, is a question. There is no general solution of this problem. Each case requires individual consideration. Either intractable pain or gangrene extending above the toes is always a clear-cut indication for operation. Pain may frequently be relieved by the repeated use of vaccines (3), by radium chloride (1), and in selected cases by lumbar ganglionectomy (3). In our experience, gangrene of such severity has not healed spontaneously. Cases of gangrene affecting only the toes in whole or in part should be treated medically, provided pain can be relieved and economic conditions permit it.

Cases treated surgically should also be treated medically to increase the blood supply postoperatively, especially if the success of the operation is doubtful. The application of radiant heat by

means of the carbon-filament electric bulb, arranged in an arch over the bed, is helpful and should be given for from 2 to 4 hours twice daily. Care must be used to avoid burning. Triple typhoid vaccine is of value if given intravenously in amounts sufficient to produce a mild chill and a systemic fever of 2 or 3 degrees Fahrenheit. The usual amount is from 10,000,000 to 50,000,000 killed organisms. This treatment can be begun on the third day after operation and given daily or on alternate days. Postoperative complications, such as pneumonia or shock, are contra-indications. Brown has shown that this method of treatment increases the temperature of the skin and the rate of heat elimination from the extremities. With increased blood supply to the extremity, healing is facilitated.

The level for amputation needs careful consideration. There are no indications for the incision of toes or the removal of toe nails. The frequency with which these procedures are carried out indicates a definite lack of knowledge regarding the nature of the disease process. The two misleading symptoms are pain, and redness of the toes. The obvious inference is that a deep-seated infection exists. This in a measure is true, but the absence of heat in the digit, the presence of similar rubor of lesser degree in other toes, the absence or diminution of pulsation in the main arteries of the feet, the history of, or presence of, superficial phlebitis, or the presence of symptoms indicating vascular occlusion (excessive fatigue or pain of the calf, arch, or ankle) give ample evidence of an underlying obliterative vascular disorder. Non-surgical methods for relief of the pain, consisting of the intravenous injection of foreign protein (3) or radium chloride (1), protection of the extremities from trauma, and medical and physical measures to increase the blood supply (3) are indicated in these cases. If pain can be relieved and trophic changes avoided, sufficient circulation may be eventually established.

The amputation of toes may be successful in 2 types of cases: those in which there is sudden thrombosis of the vessels of the toes, and those in which either or both of the main pedal vessels pulsate normally, indicating that the vascular occlusion is distal to these areas (Fig. 4). Thrombosis of the toes is manifested by sudden bluish-black discoloration, usually of 1 or more toes, with failure of return to normal color within 3 or 4 days. In our experience this occurred in cases in the early or milder stage of the disease with but little other evidence of obliterative vascular disease; it constituted an early sign of organic obliterative lesion of the arteries. Amputation in cases of thrombosis of the toes is only justified if there are open vessels and the skin appears normal proximally.

Amputation of the distal half of the foot or above the ankle has not been attempted. Healing would not be expected to occur at those levels, and even in successful cases the function would not be better than in cases successfully amputated below the knee.

Amputation in the region of the knee is necessary in cases of intractable pain or of gangrene of the toes or feet, unless it is possible to amputate the toes successfully. Amputation below the knee is not commonly acknowledged to be successful. Buerger reported 65 cases in which he performed the Gritti-Stokes amputation above the knee and believed this to be the most satisfactory operation. Telford and Stopford were of the same opinion. Jablons believed that 50 per cent of his cases were suitable for amputation below the knee.

In our series of 21 cases in which amputation was performed below the knee, there was healing by first intention in 15 cases (70 per cent). In 2 other cases, healing was prolonged. The importance of a functioning knee joint obtained by amputation below the knee cannot be too strongly stressed.

Criteria for selection of the area below the knee are not definite. Buerger believed that "methods or tests for estimating the point at which operation should be done are all unreliable." Meleney and Miller amputated below the knee in all cases if there was pulsation in the popliteal artery, and above the knee in all cases in which the popliteal artery was occluded. The results were not encouraging. Bean advised amputation above the site of closure of the main arteries. In many of our cases of successful amputation below the knee, the popliteal artery was completely occluded. In cases of œdema of the leg, of extensive gangrene of the foot and leg, of gangrenous ulcers over the tibia or knee, or of extensive cellulitis and lymphangiitis, the chances for successful amputation below the knee are less. In all other cases there is roughly an 80 per cent possibility of primary healing, provided postoperative methods for increasing the blood supply to the stump are utilized. Attempts should be made to remove the œdema by means of elevation and diuretics such as ammonium chloride and merbaphen. The patient is usually willing to take the 80 per cent chance for successful amputation below the knee in order to have a functioning knee joint. This is explained and left optional with the patient. Later amputation at a higher level in unsuccessful cases is not attended by an increased risk except in patients of

more advanced age whose gangrene is arteriosclerotic in origin. Amputation above the knee should be reserved for cases in which previous amputation below the knee was unsuccessful, for cases in which infection or trophic changes are extraordinarily extensive, and for patients unwilling to take the 20 per cent chance of failure of amputation at a lower level.

SUMMARY

Incision of toes or removal of toe nails should not be performed in cases of thrombo-angiitis obliterans. Amputation of toes can be successfully accomplished in selected cases. In approximately 80 per cent of all cases (excluding those complicated by œdema, cellulitis or extensive gangrenous changes), amputation below the knee can be successfully carried out, provided postoperative medical measures to increase the blood supply to the stump are instituted. These results demonstrate the value of close co-operation between the clinician and the surgeon. Such results cannot be obtained in older patients whose gangrene is arteriosclerotic in origin.

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THE DELIVERY OF THE ADHERENT PLACENTA

Report of Three Cases in Which The Mojon-Gabaston Method Was Employed[1]

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MANUAL removal of the adherent placenta is one of the most dangerous procedures in obstetric practice. According to Bumm (5) there is a 10 per cent mortality following this operation, and the morbidity from uterine infection has been variously estimated in the neighborhood of 25 per cent. Infection from implantation of the micro-organisms at the placental site, hæmorrhage during and after the operation, shock due to the extraction, and occasionally rupture of the uterus are the hazards of manual removal.

In the Mojon-Gabaston method, we have a means of effecting the delivery of the adherent placenta without intrauterine exploration. Briefly, this method consists in the injection of warm sterile saline solution into the placenta by way of the umbilical cord vein, so as to distend and rupture the placental vessels and form a "retroplacental hydroma"; then separation of the placenta takes place in response to the mechanical action of this hydroma.

The value of so simple a method of delivering the adherent placenta is apparent. Even in a well-equipped hospital, it has obvious advantages over manual extraction, when it proves effective. And to the physician who must work in small communities and conduct his operations under conditions in which asepsis is imperfect, it offers a special appeal. To the practitioner who finds himself confronted with the problem of an adherent placenta while delivering his patient in a country home, where trained assistants cannot be had, an alternative to manual extraction is certainly of advantage. Furthermore, in cases of precipitate labor, when there is no time to shave and prepare the external genitals properly, the danger of intra-uterine interference is considerably increased; then the Mojon-Gabaston method offers greater safety.

It is for these reasons that I am reporting three cases in which the use of the Mojon-Gabaston method brought about prompt delivery of the adherent placenta with an uneventful recovery.

[1] Read before the Beth David Hospital Clinical Society, May 2, 1927.

MANUAL EXTRACTION DANGEROUS

It is usually assumed that the placenta is abnormally adherent when it is not delivered within 2 hours after childbirth. In my experience, however, what is termed an adherent placenta often proves to be only retention, brought about by partial closure of the retraction ring. This view is supported by the opinions of other workers. Williams (29) states: "In the vast majority the term *adherent* placenta is a misnomer, since the interference with its expulsion is usually due to abnormalities in the uterine contractions rather than to abnormal adhesions between it and the uterine wall." According to Edgar (11), "adhesions between the placenta and the uterine wall are of rare occurrence, for the majority of cases thus characterized are only instances of simple retention."

Practically all authorities emphasize the dangers of manual extraction. Williams (30) advises waiting for at least 2 hours, during which time repeated attempts are to be made to effect expulsion of the placenta by the Credé method. Of course, if the condition of the patient is serious or there is free bleeding, manual extraction must be instituted earlier. Williams holds that manual removal of the placenta must never be undertaken unless this course seems absolutely necessary, as it is a more serious procedure than most obstetric operations. He points out that in the performance of a manual removal, the hand is introduced between the placenta and the uterine wall and therefore comes in direct contact with the freshly thrombosed vessels at the placental site, which afford an excellent culture medium for the bacteria thus implanted. In other obstetric operations, on the contrary, the hand or instrument touches the amniotic surface of the placenta; consequently, if any infection is introduced, it is expelled with the placenta.

Leavitt (17) holds that "manual detachment of the placenta should be undertaken only when other measures fail, not omitting their trial under narcosis." According to Sacharow (23), the manual removal of the placenta is always a serious procedure, which should be performed only after the Credé method has been tried and injection of the placenta has failed. One must bear in mind that the fundus of the uterus is thinned out during pregnancy. Consequently, if the placenta is adherent at the site of the attenuated fundus, the uterus may be ruptured during attempts at manual removal or even by too forcible Credé expression. Such cases have been reported. In some instances, an attempt at manual extraction has resulted in boring a hole through the fundus and bringing down a loop of intestine through the rent.

The mortality and morbidity statistics following manual extraction of the placenta confirm the general opinion as to the serious nature of this operation. As has been stated before, Bumm (5) attributes a 10 per cent mortality to this operation. This estimate corresponds closely to an average of all the available statistics on the subject. With regard to morbidity statistics, Bourne (4) reported 54 cases of uterine sepsis, 35 per cent, in a series of 154 manual extractions. Goethals (14) collected a series of 156 cases with uterine infection in 39, 25 per cent.

It is apparent that manual removal of the placenta is a hazardous procedure even under the best of conditions. When the operation must be undertaken in a private home without trained assistants, the dangers are greatly multiplied. Therefore, an alternative procedure of removing the adherent placenta without the necessity of introducing the hand into the uterus should prove of great value. And there is reason to believe that the Mojon-Gabaston method does indeed fill this field of usefulness.

DEVELOPMENT OF MOJON-GABASTON METHOD

In 1914, Gabaston (13), of Buenos Aires, reported an improved and satisfactory technique for the hydraulic removal of the adherent placenta, a method first described by Mojon (20), of Genoa, in 1826. It will be of interest to review briefly some of the outstanding reports concerning this procedure.

Mojon, in 1826, described his method as follows: "Water slightly acidulated with vinegar is injected with some force through the vein of the umbilical cord into the placenta, after allowing the flow and expressing of as much blood as possible from this vein by way of precaution. Whether because of the sudden pressure which the injected water exerts in the fetal placental tissue or the cold which is immediately transmitted from the placenta itself to the placental site of the uterus, in any event the desired separation takes place without the necessity of introducing the hand into the uterus. . . . In case the first injection does not prove effective, a second one may be attempted after the liquid previously injected has been evacuated."

Asdrubali (1), of Rome, in 1826 claimed priority for the method, stating that he had lectured to his students since the year 1814 that, if spirits of wine is injected into the vein of the umbilical cord, it penetrates the entire mass of the placenta and diffuses even into the finest

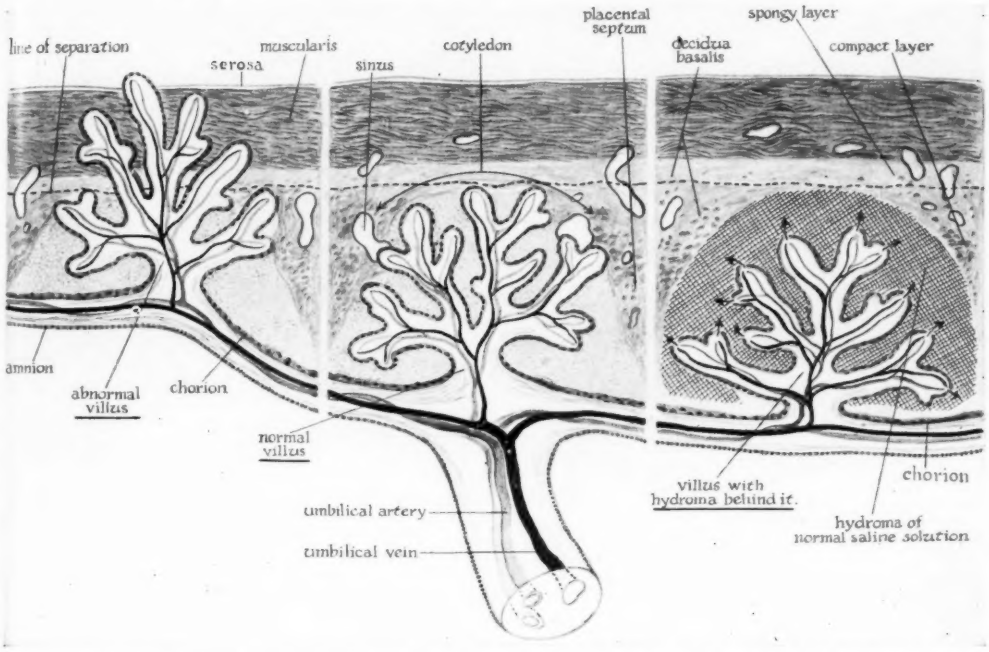

Fig. 1. Semidiagrammatic representation of the placenta and its attachment to the uterine wall, to illustrate the mechanism of the Mojon-Gabaston method. Three separate placental cotyledons are shown as follows: At center, normal cotyledon reaching to, but not beyond, the spongy layer of the decidua basalis. The section shows two branches of the villus entering uterine sinuses. At right, shows how the injection of the fluid distends and finally ruptures the finger-like projections of the villus. The cross-hatching represents the retroplacental hydroma, which completely separates the cotyledon from the maternal surface and also acts as a foreign body so as to favor expulsion. At left, a cotyledon in placenta accreta. The finger-like projections are penetrating the spongy layer of the decidua basalis and the uterine muscularis; one of them has even passed through the serosa. As placenta accreta is usually a matter of degree, some of the cotyledons remaining normally attached, the Mojon-Gabaston method may be partially effective in this condition; at least, it facilitates subsequent Credé expulsion or manual extraction. The horizontal dotted line in all three sections represents the line of separation.

ramifications, and that from that time he had conceived the idea of injecting a styptic liquid into the umbilical cord vein.

Legros (18) in 1828 found the Mojon method particularly effective in atonic bleedings. Liégard (19) in 1831 reported success with this procedure in cases in which ergot proved ineffective. Basedow (2) in 1829 tried the method several times but considered it entirely useless. Most (21) in 1834 reported that in a case of twins in which the injection was made through both umbilical cord veins "the cold developed (he employed cold water mixed with one-sixth part of vinegar) caused instantaneous cessation of the bleeding and the uterus contracted and expelled the large placenta together with the fluid injected." Schwarz (24) in 1835 reported good results not only in retention but also in uterine hæmorrhage following partial separation of the placenta. Busch (6) in 1836 recommended the injection into the umbilical cord vein of cold water mixed with vinegar for the control of hæmorrhages. D'Outrepont (10) greatly discouraged the cold injections through the umbilical vein, stating that they give rise to sudden atony, inflammations of the uterus and eventually degeneration.

While there are many more references in the literature, nothing of real importance was contributed to the subject of Mojon's method until Gabaston in 1914 described a modern application of it. It is easy to understand why the method of Mojon, while correct in mechanical principles, should have fallen into disuse because of its crudeness and the total disregard for asepsis. The injection of an unsterile mixture of water

Fig. 2. Semidiagrammatic representation of manual extraction of the placenta, showing how the intra-uterine hand comes in direct contact with the freshly thrombosed placental sinuses. In other obstetric operations, the hand touches the surface of the amnion, not the bare uterus. That is why the danger of infection from manual extraction of the placenta is especially great.

Fig. 3. The performance of the Mojon-Gabaston method. *A*, The injection of warm, sterile normal saline solution into the umbilical cord vein. The needle is held in place by the artery clamp. *B*, The position of the syringe and needle when a second injection is made. Insert shows how the needle is introduced into the umbilical cord vein parallel with its course. The vein is distinctly outlined.

and vinegar into the retained placenta is, of course, a procedure that would never have been attempted, were it not for the fact that there was no knowledge of bacteria at the time when this procedure was first employed.

The older literature shows that the Mojon method was employed by many obstetricians with a certain amount of success but with occasional mishaps, due to the crudities of the procedure and the lack of asepsis. As much of this work was performed before the era of bacteriology, the unfavorable results due to infection cannot greatly influence our appraisal of the Mojon-Gabaston method as now employed. However, the reader who wishes to obtain more details on this subject will find a complete survey of the literature in the article by Koerting (16), published in both German and Spanish.

RECENT REPORTS ON GABASTON'S TECHNIQUE

Gabaston's favorable report has been confirmed by a considerable number of other workers, but very few of these papers have appeared in English. Traugott (27) in 1917 reported five cases in which placentas retained from 70 minutes to 15 hours were easily removed by this method. In the Frankfort Clinic the results were reported in 158 cases of placental injection, and the ratio in which manual extraction was required was reduced from 4½ cases per thousand in 1911–15 to 1½ in 1916. Schwarz (24) in 1920 employed the method successfully in 11 of 16 cases, 2 of the 5 unsuccessful cases proving to be placenta accreta. Wagner (28), of the German University in Prague, favors the Mojon-Gabaston method and maintains that the incidence of manual removal of the placenta has thereby been reduced exactly one-half. He is of the opinion that the Mojon-Gabaston method is destined to replace not only manual removal of the placenta but also the Credé method of expression. In this view, he may be a little overenthusiastic. Chatillon (8) also effected a 50 per cent reduction in the number of cases requiring manual extraction by means of the hydraulic method.

Hammerschlag (15) in his *Lehrbuch der operativen Geburtshilfe* comments favorably on the Mojon-Gabaston method and cites a case in which it was used successfully. Doederlein (9), too, in his *Handbuch der Geburtshilfe Operationslehre* makes mention of this method.

Cathala and Biancani (7) recommend hydraulic expulsion of the placenta after a difficult delivery of the child, when the mother is still under the

anæsthetic, as it avoids the necessity of prolonging anæsthesia. They believe that the method is contra-indicated in uterine inertia, as it does not stimulate uterine contractions.

Ramos and Pérez (22) in 1921 employed the Mojon-Gabaston method in 28 cases of adherent placenta and were able to confirm the general impression as to its harmlessness and efficacy. In one case of twins with two placentas the hydraulic method proved exceptionally useful. In three cases of placenta prævia the injection was made immediately after the birth of the child, and the result was favorable in each case.

According to Koerting (16), distention of the placenta following injection of fluid through the umbilical cord vein often makes Credé expression and manual extraction of the placenta unnecessary. He is of the opinion that, in order to obtain the full effect of the injection, the physician should not employ expression previously. If the Credé manipulation becomes necessary, the hydraulic distention of the placenta renders it more effective. Koerting believes that when there is profuse hæmorrhage or the amount of blood lost is unknown, the Mojon-Gabastor method is contra-indicated.

Goethals (14), of Boston, believes that the Mojon-Gabaston method is the procedure of choice in cases of retained unseparated placenta without hæmorrhage and that it also deserves trial when there is slight hæmorrhage with partial separation; however, he does not believe that it can replace manual extraction when there is brisk hæmorrhage or prompt action is required.

It is not advisable to employ the Mojon-Gabaston method as a routine procedure in all deliveries. Wuhrmann's (31) statistics covering five hundred cases in which it was used as a routine show that it has many disadvantages over expectant treatment. The duration of the third stage of labor and the amount of hæmorrhage were increased. However, Wuhrmann holds that retention of the placenta constitutes an indication for the Mojon-Gabaston procedure as a routine measure when there is a history of abnormal expulsion of the placenta in previous labors.

Forget (12) in 1924 reported a case in which the use of the Mojon-Gabaston method gave an unfavorable reaction. Because the placenta was not expelled in half an hour, *water* was injected into the umbilical cord vein. Gentle traction was then made on the cord and the placenta was delivered without difficulty. Half an hour later, however, the patient had a severe chill lasting several minutes. The author attributed this

Fig. 4. Hand prepared for rectal examination. The position of the fingers within the glove is indicated by the dotted line.

untoward result to the entrance of the water into some of the uterine veins and advises caution in the use of this method of delivering the placenta. It does not appear, however, that when warm sterile saline solution is used this reaction is likely to occur.

Some observers, including W. Stoeckel (26), advise earlier and more frequent manual removal of the placenta. If the placenta is not expelled soon after the injection of the saline, the patient is anæsthetized and expression by Credé's method attempted. If there is no success, manual extraction is employed. One must not forget to catheterize the bladder before attempting artificial delivery of the placenta. In H. Bergmann's hospital (3), drugs are injected into the uterus through the abdominal wall, and this procedure is also used before expulsion of the placenta. Although permissible in cases of great uterine atony following expulsion of the placenta, injection of drugs into the uterus through the abdominal wall is not generally recommended.

TECHNIQUE OF PROCEDURE

The method of performing the Mojon-Gabaston method is quite simple. Saline tablets for the purpose of making the physiological salt solution may be obtained at any drug-store. According

to the strength of the tablet used, from one to three are added to the required amount of water, and this salt solution is sterilized by boiling. The average tablet is sufficient to make a normal saline solution from 4 ounces of water; in any event, the strength of the tablet is stated on the package.

When used, the saline solution should be warm. As a general rule, from 200 to 300 cubic centimeters of fluid are required, more if a second injection is given. The injection is made by means of a sterile Record or Luer syringe of from 20 to 100 cubic centimeters' capacity. Sometimes the introduction of 100 cubic centimeters is sufficient.

It is best to insert the needle into the cord close to the pudendum, as this portion is less likely to be soiled by fæces than the distal end. Another reason for selecting the cord close to the external genitals is the fact that the blood here is not so likely to be clotted. However, the injection should not be made too close to the pudendum, as it may be necessary to repeat it or the cord may be punctured accidentally by the point of the needle above the place of its introduction. In case the pudendum has not been prepared for labor, as in a precipitate delivery, the cord may be painted with tincture of iodine or mercurochrome at the site of the injection.

The umbilical cord vein, which gives rise to prominent convolutions on the surface of the cord, is easily located (Fig. 3, *a*). The needle, attached to the syringe, is inserted in a proximal direction into the vein, parallel with its course. It is held in place by an artery clamp (*A*, Fig. 3). If a second puncture should be necessary, but usually it is not, the first needle is withdrawn and the clamp holding it in position is tightened to prevent the return flow of saline through the puncture opening; then the second puncture is made closer to the pudendal orifice (*B*, Fig. 3).

After the needle is in its proper position, from 200 to 300 cubic centimeters of warm sterile physiological saline solution is injected slowly into the placenta through the vein. Then the physician waits for uterine contractions and the delivery of the placenta. Sometimes amounts of saline considerably less than 200 cubic centimeters are effective. In the first case I am reporting, the placenta was expelled 10 minutes after the introduction of 100 cubic centimeters.

To determine whether the placenta has been detached from the uterus but is remaining in the cervix and vagina, one should resort to rectal examination. In that event, a mild Credé expression will usually force the placenta out.

At this point, it may not be amiss to state that the more general use of rectal examinations in obstetric practice should be encouraged, especially for physicians doing general work. Many authorities hold that the patient is often potentially infected before labor, because she is then examined before her genitals are shaved and cleansed and the physician does not prepare his hands sufficiently for a vaginal examination at that time. During delivery most practitioners are sufficiently careful with their asepsis, but many are not equally cautious before the onset of labor.

Once one has become accustomed to the practice, the rectal examination is easily performed. For this purpose, the physician should carry with him a one-finger glove, which is inexpensive and requires only boiling, powdering and preservation in a clean, dry towel. Such a glove may be used for months without tearing. Figure 4 shows how the glove is slipped over the index finger and outlines the position of the remainder of the hand. By means of the rectal examination, one can without loss of much time determine whether the patient is in labor and whether she should be prepared for delivery or allowed to wait for a time.

The physician with a surgical conscience, who is strict in his asepsis and unwilling to jeopardize his patient's life for the sake of his own convenience but who is nevertheless pressed for time, frequently finds himself in a dilemma. He cannot spare the time necessary for proper preparation for vaginal examination; on the other hand, if he omits the examination, the patient may undergo precipitate labor during his absence in attendance on another patient.

The rectal examination offers the ideal alternative. It is both safe and rapid and also gives the examiner all the necessary information concerning the progress of the labor. It is for this reason that I have taken the space to urge a more general use of rectal examinations in obstetric practice.

REPORT OF CASES

Three cases of adherent placenta in which this organ was expelled in from 10 to 40 minutes after the employment of the Mojon-Gabaston method are here reported. In each case, the puerperium was uneventful.

CASE 1. P.S., aged 26, i-para, was admitted to the Beth David Hospital, January 1, 1924. The membranes had ruptured spontaneously before admission. Rectal examination showed the cervix to be dilated to the extent of two fingers. The patient was unruly and irrational and had to be restrained from inserting her own fingers into the vagina. She had a chill and the temperature rose to 104

degrees F. No fetal heart sounds were elicited. When the cervix was sufficiently dilated and the presenting part was in the mid-pelvis, medium high forceps were applied and a stillborn child delivered. Thirty minutes later, the patient began to bleed, but not alarmingly. Then an attempt was made to expel the placenta by Credé expression, but it was unsuccessful.

After a wait of 1 hour and 20 minutes, it was decided that further means would have to be taken to effect the delivery of the placenta. Since the patient had had her fingers inside the vagina on several occasions during labor and consequently the potentialities for infection were very great, I was reluctant to resort to manual extraction and decided to employ the Mojon-Gabaston method.

One hundred cubic centimeters of warm, sterile normal saline solution were injected into the umbilical cord vein by means of a 20 cubic centimeter Record syringe. Within 10 minutes the patient had a strong pain and expelled the placenta.

Four hours later, the temperature dropped to 100 degrees F. The patient ran a fairly normal postpartum course, except that the temperature rose to 101 degrees F. on the third day, when the breasts were distended. She was discharged on the tenth day in good condition.

CASE 2. B. S., aged 32, iii-para, was admitted to the Beth David Hospital, January 15, 1924. There was a normal birth at term. The duration of labor from the first pain to the birth of the child was 5 hours and 35 minutes.

One hour after delivery, mild Credé expression was performed; but the placenta was not expelled. As there was no bleeding, I waited 4 hours before invading the uterus; then I explored the uterine cavity and found the placenta firmly adherent.

Rather than attempt manual separation, I resorted to the Mojon-Gabaston method. Two hundred and fifty cubic centimeters of warm, sterile normal saline solution were injected into the umbilical cord vein, after which I waited for another 40 minutes. Then the uterine cavity was explored again, but the placenta came out with the mere introduction of the gloved hand. The solution had evidently effected mechanical separation of the placenta, so that only the stimulation of the hand was necessary to cause its expulsion.

The patient was discharged well on the tenth day. During her entire stay in the hospital, her temperature never rose above 99.5 degrees F.

CASE 3. M. W., aged 22, gravida I, married 2 years, was admitted to Sydenham Hospital, April 8, 1927. The membranes had ruptured an hour and a half previously. The patient had a long, difficult first stage of labor but was delivered of a girl weighing 7 pounds, 12 ounces, 24 hours after admission. The mother was very obese and heavy and distinctly of the hypothyroid type. She weighed 244 pounds and was 5 feet, 4 inches tall.

One hour and a half after the delivery of the child, the placenta had not yet been expelled. In a patient so extremely obese, manual extraction would have been very difficult, since there was very little room in which to work no matter how widely the thighs were separated. The Mojon-Gabaston method was employed.

Eighty cubic centimeters of warm, sterile normal saline solution were injected into the umbilical cord vein. Five minutes later the patient had a pain, but the placenta was not ejected. Then 60 cubic centimeters more of the solution were injected, and within 10 minutes the patient had two pains and expelled the placenta.

The puerperal course was uneventful and the temperature remained normal throughout this period. The patient was discharged well on the tenth day.

SUMMARY

Various statistics demonstrate that manual removal of the adherent placenta is a dangerous procedure. It has been variously estimated that the mortality is 10 per cent and the morbidity from infection of the uterus 25 per cent following this operation.

The Mojon-Gabaston method offers a useful alternative, especially in outlying homes where skilled assistants cannot be obtained and asepsis is necessarily imperfect. Essentially this method consists in the injection of 200 to 300 cubic centimeters of warm, sterile, normal saline solution into the placenta through the umbilical cord vein. This solution distends the placenta and ruptures the small vessels connecting it with the placental site of the uterus, thus forming a "retroplacental hydroma," the mechanical action of which produces separation and expulsion of the placenta.

The great majority of workers who have used the Mojon-Gabaston method report results superior to those following manual extraction. In the three cases reported by me, the placenta was delivered in from 10 to 40 minutes and the course of the puerperium was uneventful.

The following points with regard to the application of the Mojon-Gabaston method deserve special mention:

1. The procedure is simple, requiring only a few saline tablets for the solution and a Record or Luer syringe.

2. No anæsthetist is required, as for manual extraction.

3. It is not necessary to rescrub or change gloves.

4. Since the injection is made into the unsoiled portion of the protruding umbilical cord, there is no danger of carrying infection.

5. In placenta accreta, there is a possible chance of securing separation by the Mojon-Gabaston method, or by this procedure in conjunction with Credé expression. Furthermore, even if the injection of the saline does not prove effective, it facilitates the subsequent manual removal of the placenta.

6. In precipitate labor when there has been no time to prepare the external genitalia properly, manual extraction is hazardous because of the great likelihood of subsequent infection. In such cases, the Mojon-Gabaston procedure is much to be preferred.

7. The site of the injection may be touched with tincture of iodine or mercurochrome. The bladder should always be emptied before the injection.

8. In none of my three cases were there any untoward results.

9. It is very useful in febrile and infected patients.

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THE ESTIMATION OF PERMANENT FUNCTIONAL DISABILITY FOLLOWING FRACTURES

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At the present time, every physician in active practice is called upon frequently, almost daily, to examine and treat patients who have been injured in industrial occupations; the majority of injuries occurring under such circumstances, comes directly within the scope of workmen's compensation legislation. Among such injuries, fractures of bones assume a position of great importance, because some degree of permanent disability is a very frequent sequel. To call attention to the principal factors which may aid in forming an opinion as to the degree of this disability is the object of this paper.

Many injuries, while severe, cause only temporary disability. That is to say, when healing has taken place, the cure is complete, and the workman, so far as he or anyone else is able to discover, and so far as his working capacity goes, is as good as he was previous to his injury. The time required to effect the cure may vary from a few days to several months, or even longer; the disability may be very slight or only partial, or it may be complete while it lasts; regardless of all this, the essential feature of such disability is that it is *temporary*. In all such cases, after the treatment has been successful, the only question remaining for the surgeon to decide is, as to the length of the period of disability; in other words, upon what date did the healing period end, and when was full functional capacity re-established? This period of time determines the amount of compensation, which, in these cases, indemnifies only for the time lost from work. As a rule, the answer to the above question is fairly easily given.

When, however, as is unfortunately often the case, the injury, owing to its nature, determines a *permanent disability*, or reduction in functional capacity, the problem confronting the surgeon is not so simple. This disability may be complete or partial; in the latter case, it becomes the duty of the surgeon to estimate the degree. While it is true that most of the various state compensation acts contain specific schedules of indemnities for certain definite injuries, such as amputations, etc., it is obviously impossible that these could cover the whole field. It is also true that frequently these specific schedules represent mere arbitrary values which have been assigned to certain specified disabilities; such values may or may not express a true estimate. Be that as it may, we are not here concerned with definite, specific disabilities or mutilations for which definite indemnities are provided by law. But it is apparent that the range of possible disabilities is entirely too great, too many unknown factors enter into the healing of wounds, each patient is too individual in his reaction to injury, for any law to be framed which could assign a specific indemnity to every injury. Hence, every case not covered by a specific indemnity in a law must be examined carefully, and an evaluation of the existing permanent disability made as a result of such examination.

Disability, or loss of function, may be viewed under several different aspects. In the first place, we may have an *anatomical* disability. In these cases, there is an actual loss of some portion of the organism, as in an amputation of a leg. The disability may be *functional:* that is, although the disabled part has not been removed, and still forms an integral part of the organism, it is wholly or partially useless. As examples of this, may be mentioned an extremity paralyzed as a result of a fracture of the spine, or severance of a peripheral nerve, vicious union in a fracture, etc. Finally, the disability may be *professional:* in the latter case, the injured man may be completely unable to perform the work which he did previous to his accident, and yet be entirely capable of doing something else.

The degree of functional impairment or disability is expressed in percentage. Under the laws of most European countries, the normal healthy organism as a whole is considered as representing 100; estimations as to the degree of impairment, resulting from the loss of several fingers, a hand, vicious union in a fracture, etc., are made with this as a standard. Under most of our state laws, however, specific values are assigned to the various parts of the extremities, which leads to evaluation frequently upon a different basis. For example, a claimant may present himself with a stiff, almost useless wrist, the result of a fracture at the lower end of the radius. The arm above the elbow is entirely normal. Under many of our laws, the arm from the elbow down would represent 100, and the estimate of functional loss made upon this basis. Naturally, however, many conditions arise in which the functional capacity

of the body as a whole must be taken as the standard for comparison.

To estimate disability with any degree of exactitude requires a thorough examination, sound judgment, experience, and common sense. The examiner must likewise preserve a thoroughly judicial attitude. Previous to the advent of compensation legislation, which is a matter of recent years, surgeons were rarely called upon to express an opinion in exact figures as to the degree of disability in any given case; today it is a matter of daily occurrence. In the beginning, with no previous experience to serve as a guide, these opinions often represented mere guesses; today, however, by taking into consideration certain factors which have been found to be important, and by considering a case in all its aspects, an examiner can arrive at a figure which seems to be approximately correct for practical purposes; that such is the case, is demonstrated by the fact that any number of independent, experienced examiners, in reference to a given case, will arrive at very nearly the same figure, with but slight variation one way or the other.

If the estimation of disability following injuries could be reduced to a strictly mathematical basis, the problem would be comparatively simple; several attempts have been made with this object in view, but they all leave much to be desired.

Moorhead[1], suggested a standard of end-result values based on the three factors of function, union, and contour. To function, he arbitrarily assigned a value of 60 per cent, to union or healing, a value of 20 per cent, and to contour, or cosmetic result, a value of 20 per cent. Several objections may be urged against this method. The principal one is, however, that the most important element in the above formula, function, which must be known before the formula can be applied, is the one which we are most interested in determining. And function cannot be determined without taking into consideration union, or healing, which forms the second factor in the formula. Consequently, we are just as far from a mathematical basis as ever, for the estimation of function still remains a matter of personal judgment and experience, even though we wish to make use of this suggested plan. Even though this were not true, in my opinion, the value assigned to contour, or cosmetic result, is altogether too high.

The method of Kessler[2] makes use of factors which are capable of measurement with some degree of accuracy, it is true. These factors are: (1) joint movement; (2) muscular power; and (3) co-ordination and brain control. But having obtained these measurements, the problem of applying them so as to determine correctly the loss of function in a limb as a whole still remains. By assigning certain arbitrary values to the various joints and parts of an extremity, a definite figure may be obtained, but again the personal factor has entered, and in my opinion, the results are no more accurate than those obtained by a simple estimation based upon a careful consideration of all those factors present which go to make up the disability. In fact, in certain cases, the figures arrived at by Kessler's method will be entirely too high. Certain other reasonable objections to it may also be advanced, but a full discussion of the method does not come within the scope of this paper.

So far as I know, no method has been devised up to the present time into which the personal element does not enter. Consequently, none of them give figures which we can be sure are absolutely reliable, in the last analysis. Under such circumstances, I believe that an opinion based upon thorough examination, good judgment, common sense, and experience is just as valuable as one based upon the application of any arbitrary formula.

As was said previously, fractures constitute one of the most frequent of the serious industrial injuries which the general surgeon is called upon to treat; they are likewise one of the most frequent causes of permanent disability, thus giving rise to circumstances in which estimates of the degree of impairment are required. While I do not believe, as stated above, that the estimation of disabilities even approaches an exact science in a very remote degree, or that it ever will, or that there are definite rules by which correct figures may be arrived at; nevertheless there are certain conditions common to all fractures, the presence or absence of which must be established by examinations with this object in view; when this has been done, definite information is obtained upon the basis of which, if sanely interpreted, a reasonably correct estimate can be made.

The evolution of a typical fracture, for example, one of the extremities, may be considered to occupy four stages. The first stage follows immediately after the accident. It is usually short, but for various reasons may be prolonged for several days. The fracture is recent: shock if present must be combatted, the patient may have to be transported some distance, enormous

[1] Moorhead, John J. Measuring end-results after injury; a suggested percentage basis. J. Am. M. Ass., vol. lxxix, 824.

[2] Kessler, Henry H. Estimation of permanent disability in industrial accidents. J. Indust. Hygiene, 1926, viii, 211.

hæmorrhage into the tissues may prevent immediate reduction. Under these circumstances, any retentive apparatus is merely temporary.

The second stage is that of active treatment. The fracture is now reduced, and reduction maintained with suitable permanent retentive apparatus. Open operation, if indicated, is performed. If the fracture is an open one, efforts are made to prevent infection, or to treat it, if present. The aim of treatment during this stage is to secure as perfect anatomical repair as is possible.

The third stage is the stage of functional convalescence. Bony union is now well advanced, and treatment is aimed at promoting the rapid return of normal function.

The fourth stage is that of useful convalescence. In this stage, the patient returns to work. Such work is usually light in the beginning, becoming more arduous and heavy as the injured member recovers its capacity for performing its normal functions in connection with the usual occupation of the claimant. Under the best of circumstances, this recovery is ultimately complete; ordinarily, it happens that a certain degree of permanent incapacity remains.

It is thus to be seen that the aims of treatment in any fracture are twofold; first, in the beginning, anatomical repair, as perfect as possible, is to be sought for, without, however, at any time losing sight of the second, which is functional restoration. From the point of view of workmen's compensation, the latter is the more important. It is also clearly obvious that any estimate of impairment of function, or disability, to be of any value must be based upon conditions, either actual or anticipated, at the end of the fourth stage above, or when no further improvement is to be expected.

When a fracture is examined, the question to be decided is: To what extent, if any, has the functional or working capacity of the limb been impaired as a result of this fracture? To answer this, the examination must be conducted with a view to obtaining all the information possible upon the following points: (1) the condition of the fracture itself; (2) the condition of neighboring and adjacent structures; (3) the effect of each of these upon the other; (4) the effect of all these above factors, taken collectively, upon the functional efficiency of the member as a whole.

The fourth point cannot be too strongly emphasized. There may be multiple disabilities, but each one cannot be estimated separately; what is desired is the functional disability of the limb, or portion of a limb, taken as a whole, and not the various disabilities of its muscles, nerves, tendons, etc., though naturally these must have been considered before arriving at the final estimate.

Another factor, that of adaptation, undoubtedly plays an extremely important part in reducing the ultimate disability from any injury, whether fracture or not. Compensation laws, however, as a rule do not take it into account; consequently it has been excluded from consideration in this discussion. Its influence is extremely uncertain and hard to evaluate, the power of adaptation varying so greatly in different individuals; however, there is absolutely no doubt that, were it reckoned with, our present estimates would be found to be too high.

Turning now to a consideration of the condition of the fracture itself, it is of extreme importance in the first place to determine its exact location in the bone. Perfect coaptation of fragments is much easier to secure in some sites than in others; for example, as a rule, a better functional result is secured in fractures of the shaft of a bone, than in intra-articular and juxta-articular fractures. In these latter situations, perfect coaptation is often hard to obtain, while at the same time, it is of more importance than in fractures of the shaft; in addition to this, there is always more or less exudate and hæmorrhage into the joint; the period of immobilization necessary for union of the fragments greatly hinders absorption of this exudate, and adhesions will be formed which will give rise to functional disability. Naturally, the early employment of passive motion and massage in the treatment of such fractures will greatly minimize the danger of a stiff joint; nevertheless stiffness and disability sometimes remain after the best possible care, and are the rule in fracture treated by prolonged immobilization, as is still frequently the case. Disability in juxta-articular fractures may be the result of exuberant callus, leading to a limitation of joint motion.

In fractures of the shafts of certain bones, nerves may be injured, and it is important that the examination be made with this possibility in mind. Thus, in fractures at the upper end of the humerus, the circumflex nerve may be implicated; in the middle of the shaft, the musculospiral. A fracture at the upper end of the fibula may involve the peroneal.

In the forearm, exuberant callus following fracture of one of the bones may be the cause of great functional disability by preventing rotation of the radius about the ulna.

From these brief considerations, it is clear that the site of the fracture is an important factor in

estimating the resulting disability. But this is only one of them.

The alinement of the fragments may be poor: there may be incomplete apposition, or overriding; union with angular deviation of the fragments may have taken place, the so-called "vicious union"; shortening may be present; vicious callus, non-union, pseudarthrosis, all these present themselves as possible elements in evaluation.

When either delayed union or non-union is present, no correct estimate of the permanent disability can be made, and one should not be attempted. Both conditions simply mean that the evolution of the fracture is not yet complete, consequently the final examination of the case should be postponed until a later date, when no further change is to be expected.

A careful differentiation must be made between non-union and pseudarthrosis, however. Most cases of the former are readily amenable to surgical treatment, with ultimate bony union; such may or may not be true in the latter condition. When the time of consolidation of a fracture is prolonged beyond the time usual for such a fracture, the case is considered as one of delayed union; when the period of time has been much prolonged, and consolidation has not taken place, it becomes one of non-union. Such cases must be investigated very carefully. The interposition of a strip of muscle or fascia between the fractured ends of a bone may delay union indefinitely, causing the case to be considered one of pseudarthrosis; with removal of the cause for delay, however, union may promptly occur. Local or constitutional conditions which may give rise to non-union must be kept in mind and searched for and their absence established before a diagnosis of pseudarthrosis can be made. Pseudarthrosis is very frequent in cases with extensive loss of bony substance, as in gunshot wounds, compound, comminuted fractures, etc. On the other hand, severe infection may indefinitely delay union. Clinically, in pseudarthrosis, the affected part presents a high degree of abnormal mobility, while pain is entirely absent; œdema and swelling are usually absent, and the skin is more or less normal in appearance. In delayed or non-union, on the other hand, the abnormal mobility is much less pronounced, some pain is always present, the soft parts are swollen and œdematous, and the skin frequently presents a bluish or cyanotic appearance, with often, trophic changes. Skiagrams, likewise, usually show some evidence of callus formation in cases of non-union; in cases of pseudarthrosis, no callus is present, and the ends of the fragments are more or less rounded off.

What effect has an existing pseudarthrosis upon the functional efficiency of the affected limb? Naturally, under the best of circumstances, the disability is considerable; the degree, however, varies somewhat with the situation of the false joint, and with the condition of the surrounding structures. The principal consequence of a pseudarthrosis is an insufficient rigidity of the affected part. In the humerus, often to a surprising extent, this may be overcome during purposeful movements by powerful muscular contractions holding the ends of the fragments together; frequently, also, a satisfactory brace may be fitted. Pseudarthrosis of both bones of the forearm is extremely disabling, and may at times be equivalent to total functional loss of the member; if it involves but one bone, the results may or may not be serious. In regard to the radius, if the power of pronation and supination is lost, the disability is great; if there is likewise associated outward deviation of the hand, due to injury in the neighborhood of the radial epiphysis, the disability is still greater. Under such circumstances, the grip of the fingers is extremely weak. Pseudarthrosis in the ulna is much less disabling.

When we consider the lower extremity, we find that pseudarthroses here are of much greater consequence. The principal quality of the leg is solidity, and no amount of muscular contraction can furnish sufficient solidity for weight bearing; apparatus, likewise, while of some assistance, nevertheless leaves much to be desired. Pseudarthroses of the femur and tibia may at times be sufficiently disabling as to require amputation of the leg; fortunately, the former is rare. Pseudarthrosis of the fibula, alone, however, may be present with very little diminution in the function of the leg, provided that the external malleolus is intact; otherwise there will be marked outward deviation of the foot; with consequent increase in disability.

In all cases of pseudarthrosis, the condition of associated structures in the limb is of the utmost importance; interference with nerve or muscle function naturally greatly augments the degree of disability.

Union of a fracture may occur with the fragments in such a defective position that the functions of a part are seriously interfered with. Such may be the result of angulation, overriding, or some other variety of incomplete reduction. It may also be the result of too early resumption of functional activity, before sufficient bone has

formed in the callus. The effects of vicious union are, as a rule, least marked in the humerus. Here, unless nerve function is interfered with, or shortening is extreme, considerable degrees of deformity are entirely compatible with perfect, or almost perfect function of the arm. Such is not the case in the forearm. Angular deviation of either bone may seriously interfere with, if not entirely abolish, the movements of pronation and supination; in addition, if pronounced, deviation of the hand to the affected side may be produced, leading to weakening of the grip and serious disability. Angular deviation of both bones may give rise to an impairment of function amounting practically, in extreme cases, to complete loss of the hand. Deformity at the lower end of the radius gives rise to a high degree of disability, by interfering with the movements of flexion and extension at the wrist. If this is associated with tendon adhesions, stiffness of the fingers, etc., as is so often the case, the disability reaches an extreme grade, and the hand is practically useless.

Vicious union occurring in the lower extremity may likewise have serious consequences. Shortening, which is ordinarily of least importance, will be discussed later. Angular deviation, however, unless extremely slight, cannot fail to cause some disturbance of the axis of weight bearing. In the leg and foot, the arrangement of the bones, their mutual relationships, the strength of ligaments, the direction of muscular pull; in fact, the entire structure has been developed for the purpose of supporting the weight of the body, and for locomotion under normal conditions, and can only function at maximum efficiency when the line of weight bearing falls in its normal axis. Any deviation in this normal axis sets up numerous abnormal strains and stresses in the entire extremity, including frequently the pelvis and spinal column. Such a condition cannot but be productive of more or less marked loss of functional efficiency. In the milder grades, this may be manifested only as pain, resulting from tired and overstretched muscles and ligaments. Upon the resumption of activity after a period of rest, such pain may not immediately make itself felt, but after a varying period of use, it comes on and persists, constituting a marked disability in a man whose work compels him to be constantly on his feet. In all such cases, the various forces present in the extremity while it is in use should be carefully investigated. While pain, being a purely subjective manifestation, is undoubtedly often simulated, and more frequently exaggerated, nevertheless, in many of these cases, a careful study will often reveal a physical basis for it.

Marked angulation of the femur, fractures in the neighborhood of the knee and ankle joints, with union of fragments in poor position, particularly fractures of one or both malleoli, fractures of the tibial shaft, fractures of the os calcis or astragalus, fractures of the metatarsals,—all these various forms of fracture, giving rise to static disturbances, or by mechanical interference with the functions of joints, may occasion disabilities which are usually considerable, and which may occasionally be equivalent to practical loss of the member.

Fortunately, many of these conditions are today amenable to surgical treatment; such being the case, no estimate of permanent disability should be made in these cases until it is certain that no further improvement in the condition present can be hoped for from expert surgical procedure.

Another factor in evaluation which must be considered is shortening. As stated above, it has not an importance of the first order. It is due to angulation, overriding, impaction, or extensive loss of substance, such as occurs in osteomyelitis, or gunshot wounds. It is usually not marked, although occasionally it may be enormous, under which circumstances, it becomes a consideration of prime importance. In the humerus, it need enter but little into our estimate; in the forearm, much loss of substance of one bone presents an absolute obstacle to union in that bone, and we have developed a pseudarthrosis. Under certain circumstances, union with shortening of one bone may give rise to deviation of the hand to one side or the other, thus occasioning permanent disability. Shortening of both bones of the forearm, as a rule, is due to union with overriding of the fragments; in such a case, the disability present is the result of factors other than the shortening, such as loss of pronation and supination, tendon adhesions, nerve pressure, etc.

In the lower extremity, shortening of 3 to 4 centimeters is usually readily compensated for by tilting the pelvis, and does not constitute a disability; as a matter of fact, there is frequently a normal variation present in the length of the two legs. Above 4 cm., the injured person limps more or less; but with a solid extremity, good alinement, and vigorous muscular development, claudication does not constitute a very serious disability for the average workman. Naturally, with extreme degrees of shortening, the disability is correspondingly greater.

Abnormalities of the callus following a fracture are not infrequently the cause of permanent disability. The callus may be painful, from

inclusion in it of nerve fibers, or, frequently, for no reason at all that we are able to ascertain. And this painful condition may not respond to any treatment. The callus may be too large, either from overproduction in the first place, or from failure of absorption,—persistent callus. Infection is an important element in causing overproduction. When too large, the callus may interfere with the normal action of muscles and tendons, occasion difficulty in wearing shoes, and sometimes give rise to ulcerations of the overlying skin. Nerves may be included in it, with abolition of their function and peripheral paralysis. In the forearm, it may interfere with the normal movement of one bone on the other, and not infrequently leads to a fusion of the two bones.

Chronic suppuration due to osteomyelitis is not a direct factor in the evaluation of permanent disability: when such a condition is present, it represents but one stage in the evolution of the fracture. Under such circumstances, no estimate can be made with any degree of exactness, and none should be attempted; the final examination and assessment should be postponed until such time when no further treatment of any kind is indicated, and no further change in the condition of the injured member is to be expected.

All of these various pathological conditions which have just been described arise directly from, and are intimately connected with the healing of the fracture itself. Any or all of them are capable of producing varying degrees of permanent disability; consequently, in any given case, the effects of the presence of one or several of them, their degree of severity, etc., all must be taken into consideration in the final estimate of loss of function. But having done this, the list of factors giving rise to permanent disability is not yet complete. There still remain for discussion pathological conditions giving rise to disability, arising as a result of a fracture, but affecting tissues and structures other than the bone itself, such as nerves, muscles, joints, and circulatory channels.

Disturbances of nerve function may be manifested either subjectively or objectively.

The principal, if not the only subjective manifestation is pain. A certain amount of pain and soreness is so frequent following fractures that it may almost be said to be a constant finding. As a rule, however, it rapidly disappears following resumption of normal activity, to recur, perhaps, to some slight extent during damp or changeable weather. Such pain may constitute an inconvenience, it is true, but it is not a disability. On the other hand, cases are often seen in which the pain is very severe, and may persist for years. Under these circumstances, a real disability is produced. Such pain is often due to nerve compression by callus, to the inclusion of nerve fibers in a healed scar, or to factors of which we are ignorant; at any rate, no definite cause for it can be discovered. As a rule, pain in the lower extremity gives rise to more disability than pain in the upper. In all cases of alleged disability from pain, extreme care must be taken not to assign to it undue importance. Pain is easily simulated, and there is no standard by which it may be appreciated; also, there is an unconscious tendency, common to practically all human beings, to exaggerate it: in evaluating pain, therefore, these things should be taken into account. On the other hand, it should never be lost sight of that severe persistent pain is not infrequently present, particularly following fractures of the leg, and that definite, sometimes marked disability may result from it.

From an objective standpoint, we may have definite paralyses as a result of nerve injuries. When present, these are a very important factor in the determination of disabilities. Disturbance of nerve function may be the result of direct injury at the time of the fracture, or may occur secondarily from pressure by, or involvement of, the nerve in the callus. Minor degrees of functional nerve disturbance are frequently present, and are manifested by trophic disturbances, cutaneous anæsthesia, etc. The delicate, glossy condition of the skin of the hand and fingers which is so commonly observed after fractures of the forearm and wrist is undoubtedly due to interference with nerve function. Assessment in cases of severe nerve injury often presents a difficult problem, on account of the uncertain prognosis; it may not infrequently be necessary to allow several months to elapse, to allow for possible regeneration, before undertaking a final estimate. Many cases are amenable to surgical treatment, while others are not. In view of all this, extremely careful and painstaking study of all cases showing nerve involvement is necessary.

Closely associated with nerve injury is muscular atrophy. To some extent, it is constantly present following every fracture. While disuse from prolonged immobilization is commonly assigned as a cause for it, in the absence of definite nerve injury, it may well be that certain other factors are also active in every case. The chief of these is the so-called "trophic" disturbance, due probably to obscure disturbances of nerve function, but which are not due to direct trauma from the

fracture or to any of the other conditions mentioned above as causing nerve injury. Whatever the cause, the degree of muscular atrophy must always be taken into account in estimating disability.

To determine the degree of atrophy, comparative mensuration is ordinarily employed, and furnishes sufficient information for our purpose. But in taking the measurements, care must be exercised, and the sources of error and fallacies of the method kept clearly in mind. For example, the thigh, being conical, is difficult to measure correctly, unless care is taken to have both legs in the same position and equally relaxed, and unless the measurements are taken at exactly corresponding points on each extremity. On the other hand, the calf is much easier to measure, because it presents an easily accessible maximum circumference; the same is true of the upper arm, while the forearm again presents the same difficulty as the thigh. Assuming that correct measurements have been taken, however, caution must still be exercised in drawing conclusions: muscular development is frequently asymmetric. The right arm is normally larger in right-handed individuals, as is well known, and the reverse is true of those who are left-handed; the calves of the legs are often unequal in size, and it is sometimes the right, sometimes the left, which is larger; finally, certain occupations may give rise to work hypertrophy of muscles which are normally not overdeveloped in the average individual. Overriding of fragments and œdema may also add to the uncertainty. Fortunately, much assistance may be gained from palpation: in a normal individual, the muscular masses, while they may be unequal in volume, are equal in consistence; softness and flabbiness certainly indicate atrophy, and the sensation furnished by such muscles is almost characteristic. In certain cases, particularly those in which atrophy is extensive, electrical testing of the affected muscles is often of value.

The condition of the neighboring articulations following a fracture must always be a subject of careful investigation. Complete ankylosis, while it does occur, is fortunately rare; partial ankylosis is more common, and varying degrees of stiffness are present in practically every case, unless the conditions of treatment have been ideal. All of the minor forms of joint disturbance and some of the more severe ones are usually due to prolonged immobilization; others, particularly the graver types, result from the relation of the fracture to the joint, giving rise to injuries of articular cartilages, imperfect reduction of fragments, constituting actual mechanical hindrance to joint motion, etc. Limitation of joint motion may also result from scar contraction following compound fractures. Finally, all of the periarticular structures may be the seat of a pathological process, giving rise to a condition of so-called chronic arthropathy. The stiff and painful shoulder so frequently seen following trauma to this joint, particularly in middle aged and elderly patients, is a typical example of such a condition. Unless carefully treated with early massage and passive motion, fractures in the neighborhood of the wrist joint are particularly liable to leave the wrist and hand disabled, since the intimately associated flexor and extensor tendons share largely in the pathological process.

In cases of complete ankylosis, the degree of disability depends, first, upon the decrease of functional efficiency due to loss of motion in the joint, and second, which is the most important factor, upon the angle of fixation. The latter may determine the question as to whether the functional loss is 10 per cent or 100 per cent. In cases of partial ankylosis, the arc of mobility retained, whether favorable or unfavorable, is the deciding factor.

All cases of limitation of motion and of partial ankylosis are benefited by the resumption of normal activity, so far as possible; consequently no final estimate can be made before use of the extremity has been undertaken, and no further improvement is manifest. It is often astonishing to what a degree limitation of motion will disappear; naturally, such is not the case if the limitation is due to a mechanical obstacle.

Circulatory disturbances are frequently seen after fractures. After removal of a cast, the extremity commonly becomes somewhat cyanotic and œdematous for a time, particularly the leg; with use, however, in most cases, this rapidly disappears. But we sometimes see cases in which it persists. Under such circumstances, it may be due to phlebitis or to other factors, the nature of which is obscure. Occasionally this œdema becomes hard and firm, and very painful: the prognosis here is bad, the condition is more or less permanent, it gives rise to considerable impairment of function, and must be considered an important factor in estimating permanent disability.

These diverse variations from the normal which have just been discussed, the concomitants, complications, and sequelæ of fractures, represent the positive elements which must be considered in estimating the degree of functional loss. Disability is conditioned by them. It seems self-

evident in general, that the more closely the final result following fractures approaches the anatomical normal, the better the functional result. The question is summed up briefly and excellently by Llewellyn and Jones[1] as follows:

"1. A close interdependence obtains between the character of the anatomical union and the ultimate functional results.

"2. In a simple fracture, given good alinement, sound union, and the absence of complications, such is generally correlated with excellent functional results in 90.7 per cent of cases.

"3. With faulty alinement, the ultimate functional efficiency of the limb is usually impaired, and this, in general, in direct ratio to the mechanical imperfections thereof."

So far, I have attempted in this paper to discuss only those more or less definite, tangible, and principally physical conditions associated with fractures, the effects of which on the ultimate functional efficiency of the part are susceptible of measurement or estimation with an approximate degree of accuracy. Other factors are undoubtedly present to some extent in every case, and influence the ultimate result, but their effects vary so much in each individual, and are in general so intangible, that as a rule, they must be disregarded in estimating disability. A few examples may make this clearer.

The psychic attitude of the patient plays an undeniable rôle in his complete recovery. I am not here referring to cases of simulation or malingering or to the traumatic neuroses. But some cases seem to lack confidence in themselves and are unable to make a proper effort to recover function, even when the physical impairment is relatively slight, and this is true in cases where no compensation is expected.

Another factor is the personal coefficient of skill. We not infrequently see patients who have regained functional use of a member to a surprising degree, in spite of what is apparently an extremely grave physical handicap; on the other hand, patients are seen in whom the return of function is far from being what we should expect, and this in spite of their best efforts.

Closely related to the factor last mentioned is that of adaptation, or accommodation of the individual to the changed conditions following his fracture, which was briefly mentioned above. This undoubtedly plays a large rôle in every case; nevertheless, the degree to which it will bring about improvement cannot be anticipated nor estimated.

The age of the claimant is also of importance. Recovery from fractures in those past middle life is undoubtedly slower and less complete, as a rule, but even this is subject to individual variations.

In all cases, it must be clear that no opinion can be based on anatomical findings alone. While in general, as was stated above, anatomical and functional results are usually closely interdependent, yet this does not hold true in every case, and it is upon the basis of functional efficiency that we must base our estimate. In all cases, we cannot confine our examination to the fracture alone, and base our opinion upon its condition: the condition of all the parts of the affected member must be taken into consideration. If the lesions are multiple, also, we cannot evaluate them separately, assigning a certain percentage to the fracture, another percentage to loss of motion in a joint, etc. The sum of figures obtained in this way does not represent the actual disability present, but it is not infrequent to see an attempt made to arrive at it in this way. In every case, the estimate is to be made of the loss of function of the limb as a whole, and not upon that of its various parts.

[1]Pensions and the Principles of Their Evaluation. By Llewellyn and Jones. St. Louis: C. V. Mosby Co., 1919, p. 363.

SPINAL ANÆSTHESIA

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IT is obviously true that the ideal anæsthesia is local anæsthesia, and it is equally true and obvious that the ideal local anæsthetic has not as yet been found. When it is found, half of our surgical worries will be dispelled. At present we have at our command many different methods of administering local anæsthesia and many different agents for its use. Most of them are acceptable but no one of them is entirely satisfactory. Spinal anæsthesia, we believe, has its place in this group and in selected cases, according to our present standards of comparison, is as nearly satisfactory as any of the available methods. As in most innovations in surgery each has its loyal advocate—a loyalty that in some instances proves dangerous because of its blindness. In the Lankenau Clinic we began the use of spinal anæsthesia with the hope of giving the patient the benefit of its avowed advantages. We have continued its use for over 2 years with a realization of its dangers and its disadvantages, but with a recognition of its distinct advantages. It is the purpose of this paper to present the facts of spinal anæsthesia as we have learned them from our experience of over 2,000 cases. Though we have used stovaine, novocain, and scurocaine, our largest experience has been with apothesine, and it is this drug that has been used in all of the cases with which this report is concerned.

Spinal anæsthesia has been so widely used that it would seem trite to speak of its advantages and its indications were it not for the fact that one is so frequently questioned as to whether or not it is an anæsthetic of sufficient merit, safety, and advantage over general anæsthesia to justify its use. We are of the decided opinion that spinal anæsthesia is the anæsthetic of choice in selected cases, with the emphasis on selected cases. Just what types of cases we consider as belonging to these selected cases will be discussed below.

Apothesine produces a paralysis of the sensory and motor nerves involved in the area of anæsthesia. It is essentially a peripheral nerve paralysis, and has certain distinct advantages over general anæsthesia. It abolishes pain, but, unlike general anæsthesia the pain is abolished by producing a peripheral bloc to sensory stimuli, thus giving true anoci-association. This may be a factor in the lessened amount of shock shown by patients so anæsthetized. Its greatest advantage, however, and one of sufficient merit to justify its use, is the perfect relaxation which it produces. The relaxation is almost cadaveric and thus allows the operator to proceed with the minimum of technical difficulty—a distinct advantage to the patient as well as to the surgeon, no matter how skilled the latter may be. For example, we attribute our low mortality of 2 per cent in acute appendicitis partly to the fact that this form of anæsthesia is used in so many of these cases, for it allows good exposure with delicate retraction. As the effect of the anæsthesia subsides this relaxation disappears but its duration is sufficient to permit almost any abdominal operation. Its efficient effects sometimes last from 45 minutes to an hour—although it is seldom satisfactory for a longer period.

The safety of this form of anæsthesia has, in our experience, been absolute. We have never had a mortality which could be attributed directly to the anæsthetic and we have never seen a single sequela which has warranted anything more than transitory concern. We do not, however, consider it harmless. Every case in which this anæsthesia is administered is carefully selected, carefully watched, and the dose of the drug is carefully calculated and carefully given. It speaks well for the safety of the anæsthetic when we state that in this clinic the interne who administers it is changed every three months and, except for practice on the cadaver and by observing others, has had no previous experience.

INDICATIONS

There are certain types of cases which, to our mind, demand spinal anæsthesia, others in which it may be indicated, and still others in which it is definitely contra-indicated. In the past 2 years our postoperative pneumonia mortality has been reduced to a very low figure, and although there are other factors involved, such as pre-operative treatment and the comparative exclusion of ether anæsthesia, we attribute a large part of this to our practice of using spinal anæsthesia in all cases having pulmonary symptoms in which there is no definite contra-indication to spinal anæsthesia. Practically every case of intestinal obstruction is operated upon under this anæsthesia. In this type of case the technical difficulties are reduced to their lowest degree by the complete

relaxation produced by the anæsthesia. Furthermore, the tendency of the dilated intestines to fall away from the anterior abdominal wall practically abolishes the usual difficulty in replacing the eviscerated intestines and aids in decreasing the amount of shock following this operation. The technical difficulties which are to be expected in cases of large abdominal tumors, secondary operation where the viscera are bound up by adhesions, thick abdominal walls, and especially in difficult kidney operations, almost invariably disappear when spinal anæsthesia is used. Abdominal pus cases demand spinal anæsthesia, even when the blood pressure is lower than the accepted minimum in other types of cases. Here absolute relaxation is not only convenient to the surgeon but it is of vital importance to the patient. Every added traumatism used in obtaining the necessary exposure vastly increases the danger of spreading pus which nature has taken so much trouble to localize and wall off. This cannot be overemphasized, for to get good results in these cases one must handle the tissues "lovingly" and this is well nigh impossible under gas anæsthesia and often difficult under ether.

There are certain cases in which operation can be done with comparative ease under gas or ether anæsthesia, but better results are had if operation is done under spinal anæsthesia. These cases include those in which there is evidence of renal insufficiency or dysfunction, as shown by a high blood urea, albumin, and casts in the urine. It is, of course, well known that ether causes destruction of renal tissue and that traces of albumin and casts may be found in the postoperative urine of patients who have been operated under gas anæsthesia. This renal change following gas or ether in the usual case is of little moment, but when there is already some kidney deficiency before operation it becomes of greater importance. Our experience has been that cases with blood ureas above normal or showing other evidence of renal upset such as albumin, casts, etc., in the urine are much less harmed by an operation under spinal than under any form of general anæsthesia. Cases with high blood pressure present a difficult problem for any operation and for any anæsthesia. We are not particularly enthusiastic about spinal anæsthesia in these cases but we do not hesitate, in fact, we prefer to use it if there is no decided evidence of cardiac weakness. We have found that these patients do as well, if not better, with it than with ether and certainly better than with gas.

Spinal anæsthesia is given not only in the difficult cases but in those in which a prolonged surgical procedure is necessary. They practically always do better than when a general anæsthetic is given because postoperative shock is reduced. The fact that the spinal anæsthestia usually wears off before the operation is completed offers no objection to its use, for as the anæsthetic begins to lose its effect gas and oxygen may be given and the operation completed without discomfort to the patient or to the surgeon.

The one definite contra-indication to spinal anæsthesia is a low, systolic blood pressure. The accepted safe minimum systolic blood pressure is usually given as 100, but we have frequently used spinal anæsthesia in cases in which the systolic blood pressure was between 90 and 95, and have not seen any particular tendency toward more pronounced immediate untoward symptoms of the anæsthesia than in the usual case. It is, however, safer for the inexperienced surgeon to consider a systolic pressure of 100 millimeters as a minimum of safety. It is not always possible to judge how great a fall in systolic pressure will follow the anæsthesia, and it requires some experience to calculate the proper dosage and to estimate the proper amount of pressure used in the injection of the drug. It is well to remember also that it is the systolic blood pressure, at the time of operation, that is of importance. A blood pressure estimate taken days or weeks before operation cannot serve as a criterion.

There can be no doubt that the anæsthesia puts a strain upon the heart, for the sudden fall in blood pressure requires an active and efficient compensatory cardiovascular system. As there is somewhat more strain under this anæsthesia than under gas or ether we seldom give spinal anæsthesia where there is evidence of low cardiac reserve. For some time we have felt, and are now convinced, that the highly nervous, apprehensive patient is not a suitable subject for this form of anæsthesia if it is used alone. The mental chaos that these patients make for themselves offsets many of the good effects of the anæsthetic. However, in this type of patient, spinal anæsthesia in conjunction with a very light gas anæsthesia approaches the ideal. The combination provides perfect relaxation, complete sensory paralysis in the operative field with just sufficient general anæsthesia to paralyze the frontal lobes. At the completion of the operation a few inhalations of oxygen restore consciousness and relieve the patient of the distressing experience of "coming out" of the general anæsthesia; furthermore, liquids can be taken by mouth much sooner than

after general anæsthesia—trifles which often rise to importance in this type of patient.

In the aged and in the young patient the anæsthesia must be given with care. We have never given it to a patient younger than 14 years. We frequently give it to patients beyond 80 years of age, but we are always guided by the general condition of the individual and invariably proceed with caution. In the very old patient we use it most frequently for amputations of the lower extremity, for such conditions as senile gangrene. In these patients the minimum dose often suffices, and whether or not the reduction of the postoperative shock should be ascribed to anoci-association depends upon one's opinion of the theory. In some of these patients, the presence of an old osteo-arthritis involving the lumbar vertebræ offers difficulty in making a clean and smooth spinal puncture and it is, therefore, occasionally difficult to obtain a good "take." But the presence of this sequela of arthritis is not in itself a contra-indication to spinal anæsthesia. In prostatic, bladder, and uterine operations, in operations on the sigmoid, and in carcinomatous cases in which extensive bowel resection is required, this form of anæsthesia, with the exception already referred to, is the one of choice.

TYPE OF DRUG USED

As before stated our experience has been largest in the use of apothesine. We have upon occasions used stovaine, novocain, and scurocaine but have always returned to apothesine as a more favorable drug. We realize that novocain is more widely used than apothesine and with good results and therefore must conclude that novocain and apothesine are about equally efficient. It is not the purpose of this paper to advocate apothesine in favor of novocain but merely to record our experience with the latter drug. We have discarded stovaine because it is too toxic to be used with safety. Scurocaine has the advantage over apothesine in that it does not require the withdrawal of spinal fluid and that it can be used above the umbilical line, but it has the disadvantage for lower abdominal surgery in that two injections are required.

Apothesine presents two immediate untoward results. The first and the more serious is a fall in the systolic blood pressure with slow shallow respirations and a weakened pulse. To the inexperienced operator these may sometimes be alarming, but we have never found them unmanageable. The fall in the systolic pressure which rarely is as great as twenty points, is due to the direct effect of the drug in causing a paralysis of the splanchnic nerves—including the vaso-constrictors in this region, with a consequent pooling of the blood in the splanchnic vessels. This is produced with such rapidity that the remaining portion of the cardiovascular system is unable to accommodate itself immediately to the sudden loss of circulating blood, and the usual fall in the systolic pressure results. Generally, however, there is rapid accommodation on the part of the cardiovascular system, so that the only aid that is needed to produce sufficient, if not complete, accommodation is the Trendelenburg position. In fact, after the injection of the drug the patients are immediately placed in the Trendelenburg position without waiting for any further indication. Later, when the accommodation has been established, the head may with safety be raised slowly to the desired level. However, if the patient's head is raised during the course of the operation he should be most carefully watched, for sometimes the accommodation is not sufficient to offset this added burden. If the Trendelenburg position is not sufficient, an understanding of the cause of the fall in blood pressure with its resulting syncope suggests the logical use of adrenalin and caffein (usually in doses of 20 minims of the former and 2 grains of the latter), and if the condition warrants it, the intravenous injection of saline and glucose. All of our cases readily recovered under this form of treatment, but no time can be lost in deciding upon this treatment. One must not wait to see how the patient will be in a few minutes. Treatment must be prompt. We have a hypodermic of adrenalin and caffein ready for instant use and are always prepared for intravenous injection.

The other immediate untoward result and the one that is more frequently seen is vomiting. It is not serious, but it is annoying to the patient and to the operator. Just what the exact mechanism of this is we have not been able to determine to our complete satisfaction. Usually the patient does not actually vomit although he complains of severe nausea and gives every evidence of the vomiting reflex. It is perhaps better to call it a severe retching. It seems to be an admixture of both the toxic effect of the drug and the result of the upset in the cerebrospinal equilibrium due to the withdrawal of spinal fluid. It may be significant that it occurs more frequently in cases in which the injection has been high or in which a large dose has been given. It is usually controlled by inhalation of pure oxygen, and never persists throughout the operation.

Of the several more remote ill effects of the anæsthesia, the most frequent one is headache.

Headache following apothesine is peculiar in the fact that it is postural. By this we mean that the patient complains very little, if at all, as long as he is kept in the recumbent position. But as soon as his head is raised the dull heavy generalized headache sets in. A return to the recumbent position brings almost immediate relief. The cause of this headache is not as yet clear but we are of the opinion that it has not so much to do with the toxic effect of the drug as with the disturbed cerebrospinal equilibrium resulting from the withdrawal of spinal fluid at the time of the administration of the anæsthetic. We have, however, seen it occur after the administration of scurocaine in which there was no withdrawal of spinal fluid. It, perhaps, occurs more frequently in cases in which a fall in blood pressure was especially marked at the time of operation but it is also occasionally seen in cases in which there has been no especial immediate untoward effect of the drug.

This latter fact somewhat confuses an understanding of the exact etiological factor in the headache. We believe that fewer headaches would follow the anæsthesia if the withdrawal of spinal fluid could be eliminated. In the use of apothesine, however, the withdrawal of spinal fluid is essential for the production of a satisfactory anæsthesia; the same applies to novocain. Of course, the purpose of withdrawing the fluid is to produce a diffusion of the drug over a wide area in the spinal canal so that a correspondingly wide area is anæsthetized. This allows of a single injection in all abdominal operations, whereas two injections of scurocaine are required in most operations. The same amount of spinal fluid is withdrawn in each administration regardless of the dose or of the area it is desired to anæsthetize. In our experience the headache following the anæsthetic has not been of sufficient moment to offset the good effects of the anæsthesia. The headache responds best to caffein by mouth, and in the vast majority of cases subsides in a few days, but occasionally may be quite troublesome and last as long as a week, rarely more than 2 weeks. It has never been severe enough to delay the convalescence from the operation *per se*. We have never seen the severe headache immediately following the withdrawal of the spinal fluid that some authors speak of. This may be either a coincidence or due to the fact that we habitually withdraw the fluid very slowly. Whatever explanation for the headache is given, and however successfully it is treated, it nevertheless remains the most frequent and the most troublesome ill effect of apothesine anæsthesia. In our experience it occurs in approximately 1 out of every 15 cases.

The effect of the drug upon the motor nerves not infrequently produces a transient paralysis of the sphincter ani or of the vesical sphincter or the bladder musculature or both of the latter. This is always of short duration and requires no treatment other than an occasional catheterization if there is retention of urine. Catheterization is required more frequently after spinal anæsthesia than after general anæsthesia.

Occasionally the effect of the anæsthetic on the sensory nerves persists for a short time as parasthesias in the lower limbs, and a sense of numbness in the various segmental distributions of the sensory nerves. Very rarely, indeed, does the patient complain of pain referred along the course of the sciatic nerve. This has occurred in only three of our series of cases, and has never been anything more than a transient complaint, although some patients are psychically so effected that every ache and pain within reach of the site of the injection is attributed directly to the anæsthesia. This is to be expected and to be treated as the case demands.

TECHNIQUE OF APOTHESINE ANÆSTHESIA

Apothesine is chemically the hydrochloride of diethyl-amino-propyl-cinnamate. It is obtained in the form of a white powder.

The dose of apothesine in the spinal anæsthesia is 0.01 grams (grains $^1/_6$) for each 15 pounds of body weight, the minimum dose being 00.7 grams and the maximum 0.12 grams. In preparation for the injection the maximum dose, 0.12 grams, of the powder is placed in a small sterile bottle with a cork stopper. The bottle containing the powder is stoppered lightly and sterilized for 1½ hours at a dry temperature of 60 degrees centigrade. From each group of bottles so sterilized a culture is made of one or two and the remaining bottles are stoppered tightly and dipped in paraffin. The drug is then ready for use. If it has not been over-sterilized, it will not lose its potency with age.

In making the injection, the technique is the same as that used in making any ordinary spinal puncture. The patient is most conveniently placed in a sitting posture and bent forward by an assistant so as to produce a convexity of the lumbar spine and to increase the space between the vertebræ. The spine must be as relaxed as possible—a condition difficult to obtain in the excitable patient. This makes it much easier cleanly and smoothly to enter the spinal canal. After painting the skin over the proposed site of

the injection with iodine and touching the area with novocain to obviate any pain due to the insertion of the needle, the needle is placed exactly in the midline and is then pushed slowly and steadily forward and slightly upward. If bone is encountered, the needle is slightly withdrawn and again pushed forward at an angle sufficiently varied from the first to miss both the vertebræ. The needle must enter the spinal canal exactly in the midline for otherwise, even though spinal fluid is obtained, some of the drug will be infiltrated into the surrounding tissue and a good take will not be obtained. When the spinal canal has been entered, 10 cubic centimeters of fluid are routinely withdrawn. The spinal fluid is allowed to drip slowly through the needle into a medicine glass. As soon as 2 cubic centimeters have been collected, this is drawn up into a hypodermic syringe and then mixed with the sterilized 0.12 gram of apothesine which has been previously placed in a small sterile bottle. Great care must be taken to assure the complete dissolution of the drug, otherwise the results will not be good. The dose is then calculated as follows:

The 2 cubic centimeters of spinal fluid is withdrawn with its dissolved apothesine from the bottle by means of a small syringe calibrated to minims; 2½ minims of this solution is allowed for each 15 pounds of body weight, as each 2½ minims will contain 0.01 gram of apothesine. Anything above the required amount is discarded.

This method of calibration is not an absolute one but is influenced more or less by the general physical and physiological status of each individual patient. Robust patients require larger doses than patients of the same weight but of less general physical stamina. It has also been found that when operations are performed on the upper abdomen and a relatively low injection is made, a larger dose than that calibrated by the above method is necessary for a complete take. Conversely, in cases in which the site of operation is in the lower abdomen or in patients of lowered general resistance, smaller doses are not only sufficient but advisable. How great a deviation from the prescribed rule must be made in each instance is a matter requiring some experience. It is decidedly better to err on the side of conservatism.

While preparing the dose of the drug the spinal fluid is allowed to drop into the medicine glass until it measures 8 cubic centimeters, when the obturator is placed in the needle so as to prevent the escape of any more spinal fluid. The dose of the drug contained in the hypodermic syringe is then placed into the 8 cubic centimeters of spinal fluid in the medicine glass and the former well mixed with the latter by repeatedly drawing the solution into the syringe. A long, large bore needle is then attached to a 10 cubic centimeter syringe and the entire quantity of the solution drawn up into the 10 cubic centimeter syringe, care being taken that every drop of the solution is transferred from the medicine glass to the syringe. All air bubbles are then excluded from the syringe, without losing any of the solution. This needle is then thrown aside and the syringe fitted into the needle that has been allowed to remain in the spinal canal. After first making sure that the connection between the syringe and needle is secure and after slightly withdrawing the piston of the syringe to show that the point of the needle is still free in the spinal canal, the solution is injected. The amount of pressure used in this injection depends upon the amount of diffusion of the drug that is desired. For operations in the lower abdomen the amount of pressure is not of so much importance but for those in the upper abdomen it may be the deciding factor in obtaining a take or a failure. One must learn from experience just what pressure to use in each instance. Suffice it to say that high pressure is never necessary and is always inadvisable. The injection is made slowly and steadily; whether or not the solution is mixed with the free spinal fluid by repeatedly withdrawing and re-injecting the solution, depends upon the amount of diffusion desired. Some authors have advised against it because of the danger of producing a diffusion greater than that desired. Formerly we used this routinely for all operations in the upper abdomen, but at that time we were making all of our injections in the fourth lumbar space. More recently we have obtained better results in operations in the upper abdomen by making high injections (second lumbar space) and using a relatively low pressure. We do not believe that the results of withdrawing larger amounts of spinal fluid (over 10 cubic centimeters) in order to obtain wider diffusion of the drug are of sufficient merit to offset the added danger.

At the completion of the injection the needle is quickly withdrawn and the puncture wound covered with collodion. The patient is then placed in the Trendelenburg position. Better results are obtained if 4 or 5 minutes are allowed to elapse before the operation is begun, but we pay no particular attention to this, having repeatedly demonstrated that the operation can be begun almost immediately with satisfactory results.

All patients are routinely given pure oxygen through a rubber tube placed in one nostril.

This is the most efficient agent in controlling the severe retching and nausea which often follow the anæsthesia.

TREATMENT OF UNTOWARD SYMPTOMS

There are three methods of treatment used in the control of the immediate ill effects of the anæsthetic. As before stated these symptoms are all due primarily to a fall in the systolic blood pressure. The treatment is, therefore, directed to the correction of this change. For the minor symptoms the Trendelenburg position often suffices, but if this does not correct the symptoms a hypodermic of adrenalin and caffein should be given. As a rule, we give 20 minims of adrenalin and 0.12 gram of caffein. If in a reasonable time this is not followed by improvement, an intravenous infusion of saline and glucose is given. The amount of the infusion varies with the patient and the severity of the symptoms, but as a rule we give 1000 cubic centimeters of saline and 50 grams of glucose. We have never, as yet, seen a patient fail to respond to this type of treatment, and it is seldom indeed that the severity of the symptoms demands the infusion. Patients showing these immediate reactions are carefully watched for the succeeding 12 hours. The foot of the bed is kept elevated and hypodermic injections of caffein and adrenalin are given as indicated. By the end of 12 hours practically all patients show a very decided improvement, and with this the routine postoperative treatment proceeds as usual, the only difference being that water by mouth can be given at an earlier period than in cases in which a general anæsthetic is given.

REPORT OF CASES

Over a period dating from March 22, 1924, to March 22, 1927, inclusive, 2,251 cases operated upon in this clinic received apothesine anæsthesia. Of these all but 57 were regarded as takes, i.e., the anæsthetic produced anæsthesia and relaxation without the aid of a general anæsthetic. In these 57 cases the anæsthetic was not sufficient to produce the desired relaxation and a general anæsthetic had to be given before the operation was begun. There was a certain percentage of cases in which gas and oxygen was given for various reasons: (1) to allay the psychic excitement of the patient; (2) to prolong the anæsthesia when the operation extended over a considerable period of time and the anæsthesia showed signs of wearing off before the completion of the operation; (3) to control especially severe retching which has failed to respond readily to inhalations of oxygen.

An infusion of glucose and saline was found necessary in approximately two out of every one hundred patients, and an injection of caffein and adrenalin was given in about one out of every eight cases receiving spinal anæsthesia. Vomiting or retching occurred in practically every case at some time during the course of the operation. Usually this was easily controlled by inhalations of oxygen. In no case was there a mortality attributed to the effect of the anæsthesia.

Of the other sequelæ of the anæsthesia, such as incontinence of urine and fæces, paræsthesias of the leg, no definite record was kept, but we know that they were common sequelæ and that they all recovered spontaneously. We have had three patients in this series who complained of pain along the course of the sciatic nerve for from 1 to 4 weeks after the operation and in the absence of any other demonstrable cause for this symptom, we have been obliged to consider it as being in some way due to the use of spinal anæsthesia.

Our experience with apothesine has naturally become more satisfactory as our practical knowledge of it has increased. We have gained much by carefully searching for the causes of failure in unsatisfactory cases. In the great majority we have found that this was due to one of three things:

1. Occasionally a smaller dose of the drug was injected into the spinal canal than was calculated. This was because the anæsthetist failed to make sure that all of the apothesine was dissolved before making the injection. The drug is sometimes in the form of small granules, which, though high in potency, dissolve slowly. It is only too easy to fail to allow sufficient time for these granules to dissolve as they form a very small part of the powder and may therefore be overlooked. The bottle containing the solution should be held up to the light and frequently shaken in order to make sure of a complete dissolution of the drug.

2. The introduction of the needle into the spinal canal was not made cleanly and smoothly. If the point of the needle does not lie free in the spinal canal a certain portion of the injected drug will be infiltrated into the surrounding tissues.

3. The mistake of selecting a highly nervous, neurotic patient for the anæsthetic. This type of patient has given us the greatest amount of trouble with the sequelæ of the anæsthetic, such as headache. Why this is true is difficult to understand but it is a fact that these patients do better under general anæsthesia. In

operations on the upper abdomen the anæsthetic is not so satisfactory as in those in the lower abdomen but its efficiency is well marked in enough cases to justify its use. We have had better results in these cases with high injections (second lumbar space) than with low injections, and although there is greater tendency to retching at the time of operation, there are no sequelæ immediate or remote, which contra-indicate its use. For some time we have tried certain changes in our technique with the idea of preventing the occurrence of the fall in blood pressure and the retching which so frequently follows the anæsthesia. Recently some progress has been made in this direction by injection of adrenalin subcutaneously (for slow absorption) immediately after the injection of the drug into the spinal canal. While it has proved to be of undoubted value, it has not entirely prevented these sequelæ.

As stated above, we believe spinal anæsthesia has its place in the realm of anæsthetics, but we do not consider it ideal or to be used routinely. In some instances, it certainly has approached the ideal but its occasional unexplained total or partial failure denies its being, generally speaking, a completely satisfactory anæsthetic. However, when used properly, it is the best anæsthetic available at the present time. We use apothesine because we know of no drug, taking all things into consideration, that is better; we use it because we believe in its safety and its comparative efficiency, but we use it with the feeling and hope that some day it will be discarded for a better anæsthetic; adopting a popular advertising slogan—when a better anæsthetic is found, we'll use it.

RADIUM IN THE TREATMENT OF UTERINE PATHOLOGY[1]

By IRVIN ABELL, M.D., F.A.C.S., Louisville, Kentucky

THE indications for the use of radium in the treatment of pathological lesions of the uterus have been, since 1920, rather definitely defined: its dangers and the contra-indications to its employment have become equally clear. While it has not proved as widely efficacious as at first thought to be, its results in certain conditions have been demonstrated to surpass those of any other treatment heretofore employed. A brief review of the writer's limited personal experience with it in the treatment of carcinoma of the cervix, carcinoma of the body, fibromyomata, and uterine hæmorrhage of functional origin is presented as a basis for discussion of some of the problems with which such lesions are associated.

CARCINOMA OF THE CERVIX

As I became convinced that irradiation in carcinoma of the cervix offered definite advantages over the various surgical measures employed, I have since 1921 considered irradiation the treatment of choice. The considerations and observations leading to this conclusion were the greatly lessened mortality and morbidity entailed by the use of radium as compared with operative measures. The three conditions which obtained in every radical operation for cancer of the cervix, blood loss, trauma, and prolonged anæsthesia, are eliminated, thereby obviating the reduction in tissue reaction and general vitality which these factors produce. The ultimate results as related to prolongation of life and apparent cure compare favorably or excel those of operation. All but the most advanced cases can be benefited to some extent by its employment and though they finally succumb to the disease they are frequently spared the suffering induced by the hæmorrhage and infection from the foul, sloughing, vaginal mass. By far the vast majority of cervical carcinomata is of the epidermoid type which are quite susceptible to destruction by irradiation. Up to and including 1926, 30 patients with carcinoma of the cervix have been treated with radium alone and 1 with implantation of radium in the field of operation after panhysterectomy. In this latter patient, age 49 years, operated on in June, 1922, the uterus and broad ligament lymph nodes, which were palpably enlarged, were removed: the vaginal vault was left open and two 50 milligram capsules of radium were introduced, one in each broad ligament, held in place by gauze packing and removed through the vagina. This was followed by marked pelvic reaction, the entire pelvis became filled with a hard, sensitive mass, accompanied with much burning pain in bladder and rectum. During the third week, some incontinence of urine was noted, although the patient passed from 40 to 50 ounces of urine from the bladder daily. Eight weeks after operation and irradiation the mass was smaller and incontinence had all but

[1] Read before the Clinical Congress of the American College of Surgeons, Detroit, October 4–7, 1927.

disappeared when a large mass of sloughing tissue was extruded from the vagina following which total incontinence obtained. Cystoscopy, September fourth, 10 weeks after operation, showed a large vesicovaginal fistula. Death followed some months later from pelvio-abdominal extension.

Of the 30 treated with radium alone, 2 were in the third decade, ages 22 and 25 years, 2 were in the fourth decade, ages 32 and 34 years, 7 in the fifth, 12 in the sixth, and 7 in the seventh decades. The dosage given has been on an average of 3,000 milligram-hours. The patients treated during 1922 were as a rule given smaller doses and it is interesting to note that 2 of these, given respectively 2,400 and 3,000 milligram-hour doses, are known to be living and apparently free from recurrence now in their fifth year since treatment, while a further group of 3, given respectively 3,000, 3,000, and 2,400 milligram-hour doses, and now in their third year since treatment, are known to be well and apparently free of disease. Of the 31 patients in this group we have been able to trace 22, 9 of whom are known to be dead, 9 are living and state that they are apparently well, and 4 while living are known to present evidence of the continued presence of cancer.

One death occurred as the immediate result of the radium application: the patient, age 40 years, presented an epidermoid carcinoma involving chiefly the anterior lip of the cervix, presenting as a large cauliflower mass. This latter made entrance into the cervical canal difficult and in part was removed with the curette to facilitate the introduction of the radium into the canal. Forty-eight hours later she developed a temperature of 103 degrees, from which time on she presented the evidences of sepsis, complicated by a severe hæmorrhage on the seventh day, requiring packing for its control, and died on the eleventh day from what, in the light of its clinical course, was interpreted as septicæmia.

In addition to the vesicovaginal fistula mentioned above, one other has been noted. The patient, age 50 years, came under observation in October, 1921, with a vesicovaginal fistula which had followed an hysterectomy in the preceding April which she stated was done for cancer. As no evidence of the latter could be detected the fistula was repaired by the ordinary surgical measure. She was not seen again until 3 years later, December, 1924, when she presented cancerous induration and ulceration in the vaginal vault. She was given a 2,000 milligram-hour dose of radium in January, 1925, followed later by X-ray. In July, 6 months after the radium and immediately after the last of 6 X-ray treatments, incontinence of urine was noted. Examination in October showed both a vesicovaginal and a recto-vaginal fistula, and, while the patient is now still alive, she is slowly, but surely, approaching the inevitable end. The development of fistulæ in these 2 cases is in harmony with the known observation of their liable occurrence when patients presenting infiltration of vesico- and recto-vaginal septa are irradiated, and emphasize the importance of extreme caution both in dosage and technique of application when such involvement exists. In fact, in the utterly hopeless cases the possibility of fistula formation would seem to question the propriety of irradiation since such annoying complications but add to the patient's discomfort. In so far as known no patient has developed pyometra, but many have complained of persistent mucopurulent discharge which has proved resistant to treatment.

CARCINOMA OF THE FUNDUS

The use of radium alone in the treatment of carcinoma of the body of the uterus is believed by the writer to be contra-indicated for the following reasons: Cancer of the fundus is usually of the adenocarcinomatous type which does not readily respond to irradiation; its known tendency to metastasize to the ovaries makes it desirable to remove these organs in every case, and imperative to remove them if such metastasis has occurred, in order to obtain a cure; finally the results of surgery in permitting the ablation of more cancer-bearing tissue are superior to those of radium.

We have employed radium alone, or in combination with panhysterectomy in seventeen patients ranging in age from 31 to 68 years. The limitation of the treatment in 11 patients to radium alone was made necessary either by the presence of general physical conditions which prohibited the employment of a major surgical operation, or to demonstrable extension of the disease beyond the uterus, in the latter instances being used as a palliative measure for the control of bleeding. Of these, 7 are dead, death occurring in from 6 months to 3 years after irradiation; 2 are living and well, 2 and 6 years respectively after treatment; while 2 are living with demonstrable disease present, 2 and 6 years after initial treatment. Since the physical condition of this group precluded operation, radium has afforded a prolongation of life in comparative comfort for 1 as long as 6 years, while in 2 no further evidence of the disease can be detected. The dosage in these 11 cases varied from 2,400 to 3,200 milligram-hours. In the 6 instances in which radium was employed in conjunction with panhysterectomy

its use as a pre-operative measure was not an intentional one. It has been our practice to do a diagnostic curettage on every patient presenting uterine pathology on whom the use of radium is contemplated. In 6 patients presenting uterine hæmorrhage as a major symptom a curettage was done and radium applied. Subsequent examination of the removed tissue revealing adenocarcinoma panhysterectomies were done within the week. In so far as known 5 of these done from 1 to 3 years ago are well, while the sixth showed a recurrence at the end of 10 months. The location of this recurrence was of interest in that it was situated in the anterior vaginal wall below and to the left of the outer terminal portion of the urethra. Further irradiation but temporarily inhibited its spread.

FIBROMYOMATA OF THE UTERUS

The indications for the treatment of fibromyomatous growths involving the body of the uterus are variously interpreted by surgeon and radiologist. The logical analysis of the situation appears to me to be as follows: in women under 40 presenting such growths the treatment of choice is surgical removal, employing transfusion and irradiation in moderate dosage for the purpose of making operable those patients in whom continued bleeding and profound secondary anæmia temporarily prohibit operation. The reasons for this conclusion are — first, ocular inspection will in some cases permit of myomectomy with the preservation of the child-bearing function; second, preservation of the ovaries, independent of the retention or ablation of the uterine body, is of importance. The younger the patient the greater the importance of the preservation of the ovaries, because of their internal secretion and the part they play in the establishment and maintenance of the sex function, particularly in the earlier years of life. Again, many women have an abhorrence of the induced menopause regardless of how produced, whether by surgical removal of the ovaries or their destruction by radiation. Irradiation of fibromyomata in such women may engender an inferiority or abnormality complex, rendering them unhappy for the remainder of their days, and, surely, mental tranquillity transcends in importance the 2 per cent risk which operation entails. It is readily admitted that there is an opposite picture to this, namely those who desire and prefer irradiation, even though it involves destruction of the ovaries, rather than operation with its concomitant pain, discomfort, confinement, and convalescence. At and after the age of 40 years, the child-bearing function of the uterus has usually been fulfilled: the distortion of the organ incident to the growth may be such as to prevent conception, or to interfere with pregnancy, granting its occurrence, and the proximity of the approaching menopause makes negligible the importance of ovarian preservation. Hence irradiation at this age finds a comparatively wide field of usefulness, its limitations being determined by the size of the tumors and their situation, by pedunculation, by tumor degeneration, and by adnexal disease. We have employed radium alone in the treatment of 15 patients with fibromyomatous uterine growths; but 2 were under 40 (37, and 39, respectively); 8 were between 40 and 50, and 5 between 50 and 55 years of age. In 12 patients the tumor was at or below the size of a 3-month pregnancy, in 2 the size of a 4-month pregnancy, and in 1 that of a 6-month pregnancy. The dosage of the radium has varied with the size of the tumor from 1,200 to 3,000 milligram-hours. Bleeding has been controlled in every patient, and there has been an appreciable reduction in size or disappearance of the tumor in all but 3. In the first of these, a diabetic, age 54 years, with a tumor the size of a 3-month pregnancy, a 3,000 milligram-hour dose of radium was given September, 1923. In January, 1924, while bleeding had ceased, an annoying vaginal discharge was present and at times discomfort was noted in the tumor, which had not decreased in size. Supplementary X-ray treatments were made to tumor in January and February. The last examination, April 17, 1924, showed but slight reduction in size of the growth. The second, age 50 years, presented a multinodular tumor the size of a 10-week pregnancy. In May, 1925, a 1,500 milligram-hour dose of radium was applied. By September, 1924, the tumor had increased in size until it filled the pelvis and extended into the right half of the abdomen as high as the umbilicus. At operation it was found that the tumor mass originating in the body of the uterus had remained stationary in size, or possibly was slightly smaller than at the time of application of radium, while the massive increase in size had occurred in two subperitoneal nodules, one of which showed calcareous deposit. In the third patient, age 45 years, presenting a multinodular growth of the size of a 4-month pregnancy, surgical removal was advised and declined with insistence upon the use of radium: a 2,400 milligram-hour dose was given. Pain in the tumor was noted on the fifth day, accompanied by a temperature varying from 99 to 101 degrees until the ninth day when a severe rigor was followed by a temperature of 104 degrees, and

a leucocyte count of 22,000. Surgical removal was again advised and declined. The fever and leucocytosis continued with nausea and anorexia present, necessitating the administration of glucose intravenously as a means of nourishment. The tumor increased in size, reaching as high as the umbilicus, or approximately the size of a 6-month pregnancy. The blood culture was negative. Exploration through a low left paramedian incision revealed no evidence of adnexal disease, and exploratory aspiration of the tumor revealed no abscess. Death occurred at the end of 5 weeks from septic intoxication and exhaustion. While in the remaining 12 patients, cessation of bleeding and diminution of tumor occurred, a marked reaction was noted in 2 cases. One, a patient 45 years of age, had been operated on by me for cholelithiasis, at which time examination through the abdominal incision showed the pelvic organs to be normal. Eighteen months later she reported with a history of profuse bleeding, a blood count showing hæmoglobin of 59, red cells 3,200,000, and white cells 7,500 with a rounded myomatous growth 3 to 4 inches in diameter involving chiefly the posterior uterine wall. She was given a 3,000 milligram-hour dose of radium, followed on the seventh day by a temperature of 102 degrees and severe pelvic pain. The uterine tumor increased in size, the fever continued, the pain required opiates for control, the leucocytosis varied from 12,000 to 15,000, and on the twenty-third day following irradiation examination under an anæsthetic revealed the following: pelvis filled with a large mass directly continuous with uterus, filling the cul-de-sac, extending well out into both broad ligaments, and on the left side it was felt well above the pubes. The entire mass was hard, presenting no areas of softening. The aspirating needle introduced back of cervix failed to detect pus. Examination per rectum showed the mass to be adhered to the rectum and the lumen of the latter to be appreciably decreased by the inflammatory swelling. She was able to leave the hospital on the thirty-third day, making a tardy and tedious convalescence. Examination 158 days after irradiation showed the tumor to have disappeared, the uterus freely movable, the broad ligaments free, and the blood count normal. The second patient, 52 years of age, with a fibromyoma of the size of a 4-month pregnancy was given a 3,000 milligram-hour dose of radium. While the tumor decreased in size, its reduction was accompanied by pelvic pain and burning in bladder and rectum with a bloody discharge from the latter, necessitating a prolonged confinement to bed. Six months following irradiation the tumor was less than half the original size, but the patient still complained of pelvic pain and rectal irritation.

The largest tumor of the series was irradiated primarily for the purpose of controlling bleeding and making the patient operable: age 50 years, she presented a tumor the size of a 6-month pregnancy; apex beat of heart was in the anterior axillary line with a loud systolic mitral murmur; legs œdematous to knees; hæmoglobin 68; red cells, 3,560,000; white cells, 8,900. She was given a 3,000 milligram-hour dose of radium with a most happy result: at the end of 6 months the tumor had reduced to the size of a 2-month pregnancy, there had been no further bleeding, the œdema and heart murmur had disappeared, and she was symptomatically, at least, well.

UTERINE BLEEDING OF FUNCTIONAL ORIGIN

In the treatment of this pathological condition radium stands practically as a specific, finding in this field its most brilliant and consistent successes. The bleeding has been designated as myopathic, metropathic, idiopathic, and functional, the latter representing the view that is coming into general acceptance. The clinical observations offered in support of it are that the hyperplastic glandular endometrium and the bleeding occur only during the era of ovarian functional activity, that both recur after curettement and that both disappear after removal of the ovaries or radiotherapy. Further, that the removed ovaries of such patients have shown a large number of maturing follicles with an absence of corporea lutea. We have treated 70 such patients with radium, their ages ranging from 14 to 70, 1 being in the second, 10 in the third, 22 in the fourth, 29 in the fifth, 6 in the sixth, 1 in the seventh, and 1 in the eighth decades.

Physical examination showed but little if any variation from the normal in the size, contour, mobility, and position of the uterus with negative appendages, the one symptom being the bleeding. Microscopical examination of the endometrium removed with the curette has shown two types of pathology, a round-celled infiltration with vascular engorgement, and an hyperplastic glandular endometritis. One cannot emphasize too strongly the advisability of subjecting all curetted particles to microscopical analysis in order that endometrial carcinoma may not be overlooked. It is conceded that curettage suffices to cure many such cases, but an appreciable number are but temporarily benefited by this procedure, while the condition in others is actually aggravated thereby. It is in this definite class of cases that we find the true problem of the bleeding uterus,

a problem that before the advent of radium required hysterectomy for its solution. Radium, as a rule, requires but one application and the dosage can be measured fairly accurately according to whether one wishes to diminish the uterine bleeding or to produce complete cessation of menses. The induction of the menopause by radium implies the loss by the ovary of its internal secretion and of its follicular activity; consequently in cases of intractable bleeding not controlled by moderate doses it would seem wise to induce the menopause with radium only in those patients approaching middle age, reserving the surgical removal of the uterine body for younger women since it permits of the preservation of unimpaired ovaries. The dosage in this series has varied from 150 to 2,400 milligram-hours, depending on the desired result to be achieved. But 3 of the 70 patients returned on account of recurrence of bleeding. One of these, an unmarried patient, age 30 years, was under observation 2 years during which time she was curetted twice, had 2 applications of radium of 600 milligram-hours each, 2 transfusions of whole blood, 2 administrations of horse serum, glandular extracts, iron, arsenic, calcium salts, and various styptics, including ergot, hydrastis, and stypticin, with but temporary control of bleeding. Following a preference for removal of the uterus in young women rather than induction of the menopause with radium, a supracervical hysterectomy with removal of a cystic right ovary was done. Microscopical examination of the specimen showed chronic endocervicitis, chronic endometritis, and simple cysts of ovary. But one patient, age 39 years, showed any marked reaction, doubtless due to a parametrial inflammation present at time of application of radium, the ultimate result being satisfactory. One patient has noted marked vaginal spasm and dyspareunia since irradiation, and another has complained of annoying pruritis. While a certain amount of vaginal discharge is almost routinely noted following radium treatment such flow is usually of short duration and responds readily to soothing douches; in a small number of patients an intractable, irritating vaginal discharge has persisted for months. Recent communications have been received from 52 patients of this group: 36 of these, ranging in age from 38 to 50 years, to whom a dosage of from 1,000 to 2,400 milligram-hours was given, report complete cessation of menses; of 16, ranging in age from 16 to 36 years, to whom doses ranging from 150 to 800 milligram-hours were given 13 report menstruation as normal in quantity, 1 as normal for 2 years at which time radium was again used in another clinic, 1 as normal for 1 year when a curettement was done elsewhere for recurrence of bleeding, and 1 reports the bleeding as markedly lessened, but still greater than her normal.

EDITORIALS

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FEBRUARY, 1928

THORACIC CONTRAST MEDIA ROENTGENOGRAPHY

THE use of the roentgen ray in diagnosis based solely on the relative translucency to it of the tissues and organs of the body, though invaluable, would be of decidedly limited application. Lesions involving no marked or extensive change in normal tissue densities, such as ulcers, strictures, dilatations, soft tumors and abnormalities in the relative position of organs, would be, for the most part, unrevealed. The principle of contrast media delineation removed this limitation in proportion as suitable media and proper technique for their introduction were developed. Such delineation of gastro-intestinal and urinary tract lesions marks one of the greatest achievements in modern diagnosis. The Graham-Cole method of visualizing the gall bladder involved the finding of a substance opaque to the roentgen ray for selective liver secretion.

The limitations of unaided thoracic roentgenography are less marked because the air in the lungs acts as a normal contrast media bringing structures into sharp relief and accentuating the shadows of inflammatory or neoplastic increase in density.

There have been, nevertheless, very real and serious limitations to the roentgen-ray diagnosis of thoracic disease. A uniformly thickened pleura or a pleural effusion clouds the contrast media effect of the air in the lungs and effectively masks any coexisting pulmonary lesion. Intrapulmonary shadows that are revealed may also be of uncertain or indeterminate significance. The heart and dome of the diaphragm overshadow markings of lung pathology. Air containing dilatations or cavities or strictures of bronchi may produce no definite findings. The exact status of fistulous tracts and empyema cavities is not demonstrable without the use of suitable contrast media.

The great value of bismuth paste in the study of sinuses and cavities was brought out by Beck but this media, if introduced under pressure into an empyema sinus, may produce symptoms of serious cerebral manifestations, sometimes suddenly fatal. It is also unsuited for intratracheal injection of the bronchi. Solutions of sodium iodide or other salts serve well to outline empyema cavities but are too irritating to be injected into the bronchial tract.

The possibility of visualizing the bronchial tree roentgenographically was suggested by the accidental penetration of small amounts of bismuth paste into the trachea through tracheal-œsophageal fistulæ. In 1918, Chevalier Jackson succeeded in outlining the right bronchus by insufflating into it bismuth powder through the bronchoscope. Two years later Lynah reported 2 cases of pulmonary abscess similarly visualized. The necessity for bronchoscopic introduction of the powder and

its limited distribution, however, would probably have greatly limited the applicability of this method, even if more suitable media had not been developed. The preparation of 40 per cent metallic iodine in poppy seed oil, introduced by Sicard and Forestier in 1921, making roentgen-ray bronchography relatively safe and practical, promises to be as notable an achievement in the diagnosis of thoracic disease as the bismuth meal or enema has proved in that of the gastro-intestinal tract. The "iodopin" of the Germans and "iodumbrin" of the Danes are similar preparations.

The greatest field of usefulness of these contrast media is in the differential diagnosis of bronchiectasis, which next to tuberculosis is the most common chronic pulmonary disease.

The physical signs of bronchiectasis are often limited to a few râles and the roentgen-ray findings to linear shadows of uncertain significance. In combination with chronic cough and an abundance of purulent sputum showing no tubercle bacilli, these findings should serve to establish the diagnosis, but the type and distribution of the bronchiectatic dilatations remains indeterminate. It is often impossible to differentiate between unilateral and bilateral involvement except perhaps bronchoscopically. The disease has often masqueraded for years as chronic bronchitis, tuberculosis, abscess, or recurrent "colds." Early diagnosis has been the exception. It has probably never been diagnosed with certainty in its incipiency. The dry type of bronchiectatic dilatations producing no cough or sputum, presumably of congenital origin, probably has never been recognized except at necropsy. In the iodized oil contrast media, we have a means of visualizing the dilatations in the earliest stages of the disease when most amenable to treatment, and of determining objectively the best type of treatment. Bronchiectasis coexisting with thickened pleura, empyema, tuberculosis, or subphrenic abscess can be recognized with certainty only by such contrast media visualization.

Pulmonary abscess with wide open communications with a large bronchus may be directly visualized with iodized oil if empty or after having been emptied bronchoscopically, but the oil may entirely fail to gravitate into those with imperfect drainage, notably those situated peripherally. In many such cases the injection of the bronchi leading to the diseased area of the lung furnished indirect evidence of the presence of an abscess, in that the lipiodol fails to penetrate into the terminal bronchi in the surrounding consolidated lung tissue. This abrupt ending of the bronchial shadows also serves to differentiate between lung consolidation and localized pleurisy with or without effusion. After thoracotomy drainage, the lipiodol may give an excellent delineation of a multilocular abscess cavity and of its fistulous ramification.

In empyema the method is of great value in establishing the presence and ramifications of bronchial or intrapleural fistulous tracts or multiple communicating cavities.

Bronchogenic tumors of the lung, the incidence of which seems to be on the increase, as a rule, are recognized late, if at all, clinically. The dilatations or blockage of the bronchi as shown by the injected oil, whether with or without symptoms of infection, suggest the possibility of a neoplasm as the underlying lesion.

In pulmonary tuberculosis the method serves to outline cavities and secondary bronchiectasis, but cases have been reported seeming to show that the iodine gradually set free may stimulate the tuberculous process to renewed activity. The value of the visualization is also minimized from the standpoint of treatment, as indications for compression therapy must usually be determined on other grounds.

The application of the principle of contrast media roentgenography to the study of the diseases of the thorax made possible by the development of iodized oil thus seems of the greatest importance to their earlier and more accurate diagnosis and more rational and effective treatment. CARL A. HEDBLOM.

THE SPLEEN

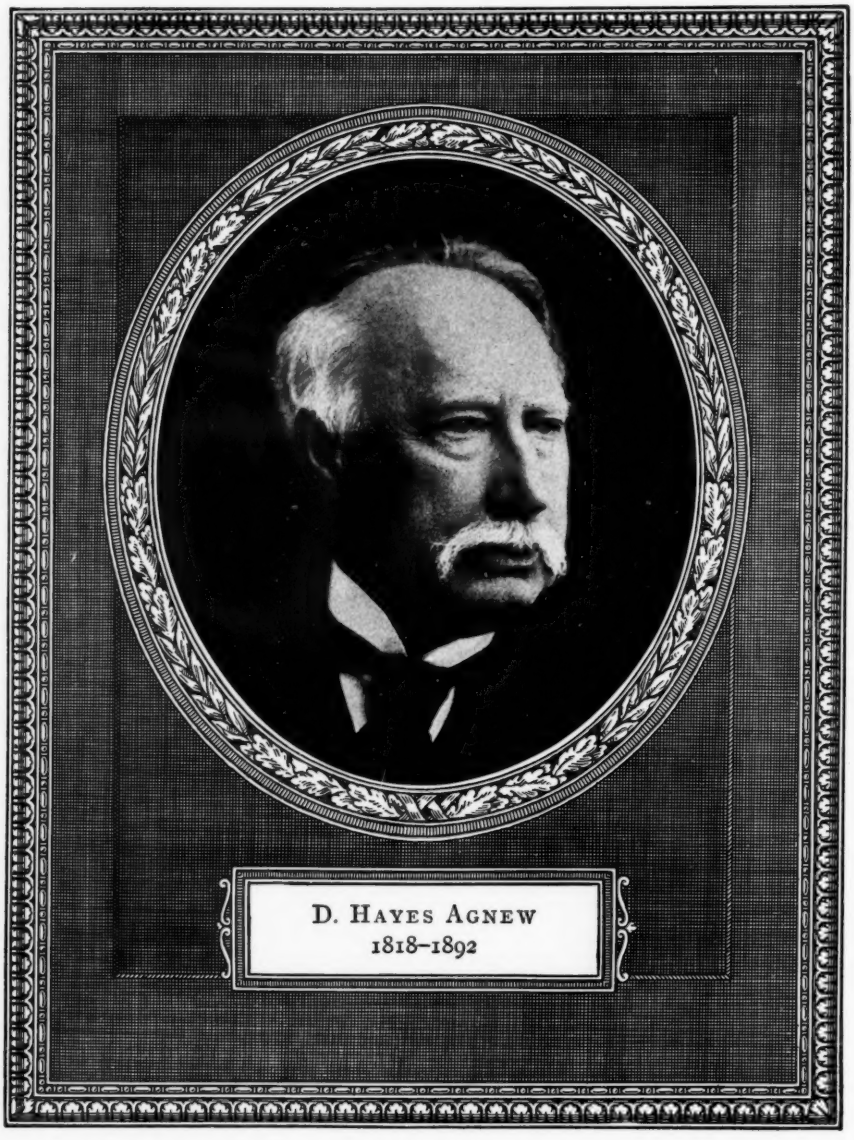
THE spleen cannot be regarded as an organ apart, but only in relation to various systems: lymphatic, circulatory portal, and reticulo-endothelial. It is affected reflexly by various forms of stimulation and in turn has a direct effect on the blood.

Removal of the spleen in man preceded its removal in the experimental animal, and much of our knowledge concerning the spleen has been derived empirically as a result of extirpation of the spleen. It is interesting to note that many of the views of the ancients have been corroborated. Anatomical and pathological studies have failed to throw much light on the function of the spleen, but recent physiological and chemical research has revealed interesting facts which seem to indicate that our fundamental knowledge will be obtained by experimental work.

Although the spleen contains a large amount of lymphoid tissue, the activities of this tissue are not clearly understood, and it is only in pathological lymphocytic hyperplasia of the spleen that the lymphoid characteristics assume prominence. It has been clearly shown that the normal spleen exerts a balance on the circulation both with respect to blood volume and the number of erythrocytes, especially during exercise and hæmorrhage. The direct effect of removal of the spleen on the amount of blood passing through the liver has been demonstrated; the enlarged spleen in certain pathological states contains enormous quantities of blood, and in these cases the degree of relief of the load on the diseased liver assumes definite proportions. The effect of the spleen on the blood is demonstrated by the recovery of the normal platelet count in cases of hæmorrhagic purpura following splenectomy; this recovery is so rapid that a direct effect must be postulated, and it is probable that in this disease the spleen destroys platelets, possibly chiefly the older forms of platelets. The reaction of the spleen in chronic infectious processes seems to have little to do with the reticulo-endothelial structures; it affects chiefly the circulatory system and fibrous tissue, producing chronic fibrosis and often infarcts.

The idea is general among the laity that persons from whom the spleen has been removed do not live long. This misunderstanding is doubtless due to the fact that in many instances the spleen has been removed not with the expectation of cure but with the idea of prolonging life. It seems important, therefore, that the public should be informed that cure can be expected only in certain diseases, of which the outstanding examples are hæmolytic icterus, purpura hæmorrhagica, splenic anæmia, and syphilitic splenomegaly. Results obtained from splenectomy in cases showing the syndrome of splenic anæmia are unsatisfactory partly because splenectomy has been performed in cases in which on careful study the condition seems to be the result of a chronic recurring infectious process.

The most interesting problems at present from the experimental standpoint are those in connection with the spleen as a part of the reticulo-endothelial system, and from the clinical standpoint are those concerned with the determination of the advisability of splenectomy in the individual case; this, after a satisfactory diagnosis has been reached, seems to be chiefly decided by satisfactory function of the liver and absence of evidence of chronic recurring infection. H. Z. GIFFIN.



D. HAYES AGNEW
1818–1892

MASTER SURGEONS OF AMERICA

D. HAYES AGNEW

ON mid-days of the late seventies and early eighties, for instance 1883, in an ill lighted, worse ventilated, superheated lecture room of the typical funnel shape not yet extinct; on straight backed benches of incredible hardness and discomfort, some two hundred and fifty smoking, singing, whistling, bantering, tussling students waited the coming of the John Rhea Barton professor of the principles and practice of surgery in the Medical School of the University of Pennsylvania.

On the minute of twelve, through the swinging door of the pit entrance came D. Hayes Agnew. Tall, lean, lithe, florid; white hair somewhat long as was his drooping moustache; bushy eyebrows over clear, keen blue eyes; slender, shapely hands of great strength. Wearing a high stock, a frock coat, dark trousers, changed to light in the spring, and highly polished boots accentuating small, narrow feet.

With Agnew's entrance the tumult of waiting, exuberant youth gave way to a brief burst of applause, something more cordial than the perfunctory hand clapping with which all other professors were then greeted.

The brief rustle of opening note books was followed by a moment of attentive silence broken by Agnew's agreeable, well modulated voice setting forth with singular clarity and directness the groundwork upon which the practice of surgery should be built.

At the hour's end, as Agnew left the room, again there was applause, vigorous and astonishingly prolonged since it was the students' lunch hour. Thereafter the crackling of matches, the trampling of many feet, the joyous, careless hurry of healthy youth, keen for that boarding-house fare which, while condemned as uneatable, was consumed in such quantity as to render the entire class somnolently unreceptive to the first afternoon lecture.

Agnew lectured to crowded classes, though no effort was made to keep a record of attendance. He based his surgical teaching on anatomy, symptomatology, a sharp knife, and a hand trained in its use. His talks were forceful, enduring in their effect. His demonstrations were astonishing in their smooth swiftness and surety of result.

Agnew was of Scotch-Irish descent and inherited his height, since his great grandfather, Robert, the shortest of seven brothers, measured 6 feet 2 inches. His grandfather, David, one of nine children, became the father of twelve and died leaving a widow who married a widower whose children numbered seven.

His father, Robert Agnew, a graduate of Dickinson College, a surgeon of note and an elder in the Presbyterian church, married a handsome widow, the mother of two children, who bore to him David Hayes Agnew. The latter received his literary education at Jefferson College, Canonsburg, Pennsylvania, the stronghold of Presbyterianism, subsequently becoming part of Washington and Jefferson College at Washington, Pennsylvania, and writes of this institution, he then being eighteen years old, that "the refectory was infamous, the food was poor and badly served," a criticism which has always been voiced of all educational institutions by each generation of students.

After graduation from the Medical Department of the University of Pennsylvania, Agnew practiced at Nobleville and Christiana for three years. He records at this time that it was "hard riding, hard reading, hard working, small fees." He played the violin, followed the hounds, owned and rode a famous horse of the "Tom" breed, was a lover and trainer of dogs, and was known throughout the countryside as a dead shot and a judge of horses.

Marrying into a family interested in the iron business, he was persuaded to abandon for a time the practice of medicine in favor of a business career. His firm later assigned, and it is worthy of note that Agnew ultimately paid every penny of the loss sustained by those who invested therein.

Thereafter he returned to the practice of medicine and settled in Cochranville, Chester County, Pennsylvania, but remained as in student days vividly interested in anatomy, securing bodies for the purpose of dissection and study from Philadelphia and placing the bones in a pond to be cleaned by the eels which were much esteemed as food by the community. Agnew's method of fattening them was not approved, nor for that matter was the use of the human body for scientific purposes. Falling into disfavor in his community, he determined to settle in Philadelphia, but at the request of Dr. Sample took charge of the neglected practice of the latter's son at Soudersburg, ten miles from Lancaster. Speaking of his experience there many years later, Agnew said: "I located at Soudersburg when a young man; I stayed there long enough to know all the roads in the district, but I found the people there wanted a better doctor than I was likely to prove, so I moved."

It was perhaps at this time that he found some comfort in Voltaire's definition of a physician: "An unfortunate gentleman who is expected to perform a miracle every day in reconciling health with intemperance."

Coming to Philadelphia and finding at last his true bent, he threw all his energy into his school of anatomy, of which he took charge in 1852. At this time

the use of the human body for dissection was not regarded with such favor by the laity nor with such large tolerance by legislators as to make the securing of adequate material other than difficult and dangerous. Agnew's supply was always adequate. During the cholera epidemic, he might have been, but fortunately was not, found in those trenches where the almshouse bodies were dumped, injecting by day and resurrecting by night.

During the more than ten years of his control of the anatomical school he delivered over 1,800 lectures, teaching and demonstrating both summer and winter. An associate, Dr. Garretson, speaks of him as having an uniquely unspeculative mind on the subject of religion. When questioned as to body, ego, and soul, Agnew briefly replied that he was sure of the body, was willing to leave the ego to philosophy, the soul to the church.

Agnew's growth to the master position was slow; even slower was the recognition by the schoolmen that he had attained this growth. Appointed by Leidy demonstrator of anatomy in the University of Pennsylvania, he remained in this minor position seven years, when, because of his increasing practice tendering his resignation, he was made professor of clinical and demonstrative surgery; this when he was 52 years old and had been practicing medicine thirty-one years. A year later he was made professor of surgery, retaining this position for eighteen years.

By the early eighties Agnew was recognized by both the medical profession and the laity as the master surgeon of America: by the medical profession because of his headship and conduct of the Philadelphia School of Anatomy which, meagerly equipped and with but nine students, he bought in 1852 for six hundred dollars and sold for the same sum in 1863 with full equipment and 267 students, the world's largest private class under an individual teacher; also, his leading rank was accorded him by the profession because of his large army and hospital experience, his textbook on surgery and his papers on applied anatomy which were recognized and accepted as standard of authority.

Hence, when President Garfield was shot in 1881, his attending surgeon looked on Agnew as the obvious consultant. His connection with this case and his bearing throughout stamped him to the layman as a leader.

As Garfield, about to take a train, was passing through the Baltimore and Potomac Railroad Station he was shot, the bullet entering four inches to the right of the midline of the back at the level of the eleventh rib. Garfield fell and, when carried to the second story of the station, was pale, cold, wet, thirsty, vomiting; with a running pulse, and suffering severe pain and marked hyperæsthesia of the legs, particularly marked on the right side. The surgeon promptly probed downward to the depth of 3½ inches and followed his metal instrument by his little finger introduced to its full length.

The reaction from shock was slow but complete. The next day the surgeon general made a further digital exploration of the wound tract; and, of the

consultants called on the third day, it is stated they did not attempt to force their probing with too much vigor. There is no record to the effect that Nélaton turned in his grave nor that Lister groaned aloud, though there was at the time a protest regarded by both the profession and the laity as inspired by envy and voiced by the votaries of the false god antisepsis, whose credo failed to recognize wound suppuration as inevitable, and whose cult enforced a time consuming ritual, with results no better, if as good, as those incident to methods sanctioned by the centuries. Agnew, called on the third day, decided against operation, and thereafter was concerned with insuring drainage for an abscess burrowing into the iliac fossa and for other septic manifestations, among them sloughing parotids.

When death occurred some two and a half months later, the bullet was found harmlessly encysted remote from the suppurating area which centered around an osteomyelitis at the seat of the shattered vertebral body.

Agnew was brought up strictly in the tenets of Presbyterianism, attended church regularly, refusing all posts of honor therein. He saw on Sunday only those patients whose needs were urgent; was quietly, deeply and consistently religious.

As a teacher he had that rare gift of clarity, accentuating and illumining the high points, avoiding unessential and confusing details. He believed and taught that surgery should be based on a brain-eye-and-hand knowledge of anatomy, a sharp knife, fingers trained in its use, practiced diagnostic ability, and an understanding heart tender toward the afflicted and with the single purpose of bringing help to both body and mind.

This being before the efflorescence of specialists, subjects now relegated to them were grouped in the surgical course, among them affections of the skin, which Agnew briefly covered by the statement that they might be classified under two headings, namely: those which are cured by the application of zinc oxide ointment, and those which are not thus cured.

He believed that woman's place was in the home, that her education should be confined to reading, writing, arithmetic, belles lettres, and housekeeping, and was so opposed to her as a medical student that he resigned from the Pennsylvania Hospital staff rather than have one or more attend his clinics.

He was among the first in this country to practice the ritual of Listerism; this at an age when "upon many minds a new idea has the effect of a foreign body upon the grosser tissues, and is either encapsulated and disappears or sets up an irritation and is extruded" (J. William White).

He was ambidextrous, deft, and swift in his manipulations without seeming so to be. Students crowded his clinics; in particular those devoted to cutting for bladder stone. When a patient was assuredly diagnosed by means of a resonator attached to a steel sound and was duly prepared, with a grooved staff passed into the bladder, Agnew would make one ample perineal cut into the posterior urethra, drop

his sharp pointed knife, take from his teeth his blunt pointed one, make with it one further ample cut through a lateral lobe of the prostate, insert his forceps, and remove the stone in less than six seconds; and with a deceptive appearance of deliberation.

Agnew was a scrupulous observer of professional etiquette both in action and in spirit. Operating upon a patient suffering from a long-continued suppuration, following an operation by a brother practitioner, Agnew made one deep free incision, seeming to his resident perilously near the femoral artery, passed in two fingers, so neatly palmed a lingering sponge which had been the cause of the trouble that it was seen only by his assistant, and made no remark other than "this free drainage should cure your patient, Doctor."

Agnew died of angina pectoris aggravated by influenza. To his students and colleagues he was Master not only because of his textbooks, his honors, his manual dexterity and surgical skill, his diagnostic acumen, his clarity of thought and expression, but because of a personality which in either group or individual contact left an impression of singleness of purpose, of joy in service, of sympathy with weakness, of an understanding heart. A personality actively and beneficently contagious.

In the University of Pennsylvania there is an Agnew wing endowed by the Master. In the Library of the College of Physicians there is an admirable Biography of D. Hayes Agnew written by his nephew, Dr. Howe Adams, and from which much that has been written in this sketch has been taken.

Even the most powerful in his day and generation is promptly forgotten unless he leave a named legacy. The Agnew wing should be the Master's benediction for many generations of teachers, students, and patients. EDWARD MARTIN.

D. Hayes Agnew was born in 1818, died in 1892. He received an M.D. degree at University of Pennsylvania in 1838. He was owner and conductor of Philadelphia School of Anatomy, 1852–63. He was acting assistant surgeon, U. S. Army and consultant to group hospitals. Demonstrator of Anatomy, University of Pennsylvania, 1863–70. Professor of clinical and demonstrative surgery, University of Pennsylvania, 1870. John Rhea Barton professor of surgery, 1871–89. Emeritus professor of surgery, 1889–92. Surgeon to Philadelphia Hospital, Pennsylvania Hospital, Wills Eye Hospital, Orthopædic Hospital. He was author of *Principles and Practice of Surgery*, 3 vols., 1878–81–83; *Regional Anatomy in Its Relation to Medicine and Surgery; Researches on Organization of Blood Clot and on Repair of Fracture*, and many contributions to textbooks, encyclopædias, and current medical literature. He was president of the College of Physicians, president of The American Surgical Society, founder and president of the Academy of Surgery, member of The American Philosophical Society, and member of the Board of Directors of the Union Trust Company.

THE SURGEON'S LIBRARY

OLD MASTERPIECES IN SURGERY

By ALFRED BROWN, M.D., F.A.C.S., Omaha

CONCERNING DISEASES OF WOMEN—HIERONYMUS MERCURIALIS

IN the sixteenth century, obstetrics and gynecology, as well as surgery, came in for a certain share of attention. Based upon the work of Soranus, of Ephesus, followed by that of Trotula at Salerno, Eucharius Roesslin, of Wurms, published his *Rosengarten* in 1513, in which he taught the podalic version first suggested by Soranus. By this he furnished the inspiration to a few men for more careful consideration and study of this phase of medicine. In England the *Rosegarden* was translated from the Latin into English by one Richard Jonas and appeared in 1540 under the title *De Partu Hominis*. Subsequently, practically the same work appeared under the title of *Byrth of Mankynde* with the name of an Englishman, "Thomas Raynold, physition" as author, and was the authority on obstetrics in England for over a century.

By these two works, Germany and England were supplied with manuals on obstetrics which served for teaching purposes. Switzerland was soon supplied through the instrumentality of Jacob Rueff who published his "Ein schoen lustig Trostbuechle" in 1554, in which, in addition to the purely obstetrical portion, there is included a chapter on monsters. In France the subject of obstetrics was taken up by Paré and as in all things he attempted he popularized the then methods and added new ones. He advocated podalic version and was the first to introduce labor at term to check hæmorrhage. A lesser known physician of Paris, Nicolus Rocheus, also wrote a work on obstetrics. As was to be expected, Italy kept pace with the advances made in other parts of Europe in this department of medicine. Very little escaped the notice of the great University of Padua and Jacobus Sylvius, and Vitorrio Trincavello taught obstetrics and diseases of women. Ludovicus Bonaciolus, a professor in Ferrara, also taught and wrote on the subject.

The largest work on obstetrics and gynecology by an Italian, during the sixteenth century, was the one based upon the lectures given by Hieronymus Mercurialis, presumably when he followed Trincavello as professor at Padua upon the latter's death in 1568. Mercurialis wrote or lectured on nearly all the recognized departments of medicine and among others covered the subjects of obstetrics and gynecology. The book was not written by him but like many of the volumes attributed to him was apparently a transcription of his lectures by one of his students, subsequently corrected by him. The *Lectures on Diseases of Women* was first published at Basel in 1582. Later it appeared as part of a general work on gynecology published in 1586, and the volume here illustrated appeared in Venice in 1587 printed by Valgrisius. It was also published in Strassburg in 1597.

This volume was the combined work of two of Mercurialis' pupils, for the title page reads: "*Lectures Concerning the Diseases of Women* from the lips of Hieronymus Mercurialis recently edited by Caspar Bauhin, an author until lately little known. Now Truly enlarged and amended, with the consent of the author, by Michele Colombo from the collation of many examples. With an exhaustive index of chapters and contents. 1587, at Venice, at the house of Felix Valgrisius." The book is thus an example of a procedure common during the sixteenth century, when each professor in a large school had his Boswell, usually in the person of one of his students or assistants. The amanuensis took notes on the lectures and wrote them up. They were then corrected by the professor and published. In this way the ideas and opinions of these men, too much taken up with other matters to do their own writing, have been handed down to us. A list of authors cited in an earlier German edition of 1586 contains one hundred and one names and conveys an idea that the seven years' study by Mercurialis in Rome had given him a great knowledge of the literature of the ancients. As was often the case, however, the names of recent authors or contemporaries are lacking and though Soranus, Trotula, and others are mentioned, the names of Roesslin, Jonas, Raynalde, Rueff, Paré, and others are lacking. It would seem nevertheless that Mercurialis was at least conversant with their work for, in the second book which deals with labor, he describes podalic version which was at the time being popularized by Paré in France.

The first three books deal with obstetrics, treating in succession, conception, pregnancy, labor, and the puerperium. The fourth book deals with diseases of the genitalia; irregularities of menstruation, gonorrhœa, the white menses (leucorrhœa), pruritus, and other conditions both physical and psychic. A definite form of description is used throughout consisting of a description of the disease, the causes, the symptoms, the prognosis, and the treatment.

DE MORBIS MVLIEBRIBVS

Prælectiones ex ore

HIERONYMI MERCVRIALIS

Iam dudum à Gaſpare Bauhino exceptæ,
ac paulo antea inſcio autore editę:

NVNC VERO PER

MICHAELEM COLVMBVM

Ex collatione plurium exemplarium conſenſu auctoris locupletiores, & emendatiores factæ.

CVM INDICE CAPITVM, ET RERVM LOCVPLETISSIMO.

M. D. LXXXVII.

Venetiis, Apud Felicem Valgriſium.

REVIEWS OF NEW BOOKS.

THE ninth edition of Cabot's *Physical Diagnosis*[1] has been carefully revised. Analyses of further statistics have been added so that this work becomes not only a didactic presentation of physical signs but one on general differential diagnosis. In the chapter on heart murmurs the corresponding numbers of phonographic records are attached to the diagrams. This should be of great value for teaching and for ear training. In opening the discussion on auscultation, the author describes the multiple Bowle's stethoscope. This suggests the multiple electrical stethoscope which by amplification and transmission of heart sounds enables an auditorium full of students to listen simultaneously with their teacher. This is a device which Doctor Cabot has used with great success in teaching.

The volume continues to be the best short work in its field. It is full of characteristic, refreshing denials such as "I can recognize no tricuspid murmurs" and "I never heard this sound." Conclusions are arrived at with originality and disregard for opinion since they are based upon first hand analysis of his own statistics. Most interesting deductions are made. Some of these are old and have long been supported by experience, such as the remark that urine tests for indican, urea, sulphates and phosphates give "the appearance of accuracy and scientific method in diagnosis but not the reality." Other statements such as "I have never seen any evidence that excessive muscular work is *by itself* capable of causing cardiac hypertrophy and dilatation," tend to be supported by the most recent physiological work.

Thus, for extent of material presented and for stimulating observation this volume continues to be one worth repeated study. PAUL STARR.

IN this interesting volume containing thirty-seven of the Practical Lectures,[2] delivered before the Kings County Medical Society, men of prominence in the various specialties have been selected to present subjects most likely to be of value to the doctor in general practice.

Several of the lectures have particular interest. George W. Crile's "The Surgical Treatment of the Thyroid Gland" is based on his experience in performing 13,988 operations upon the thyroid gland. The United States Public Health Service is explained by Surgeon-General Hugh S. Cumming. "The Doctor in Court" is full of interest and instruction for those unfortunate enough to have to go there.

Haven Emerson gives his reasons for advocating periodical health examinations. John H. Gibbon, in his "Common Sense in the Treatment of Fractures" very properly includes commendation of the massage methods of Lucas-Championniere.

"Inherited Syphilis" is well covered. Foster Kennedy contributes a lecture on "Fits." Frank H. Lahey discusses the "Varieties and Treatment of Goiter." George M. MacKee devotes 64 pages to the "More Common Diseases of the Skin." John O. Polak lectures on "Toxæmias of Pregnancy."

The subjects are handled in a somewhat elementary manner but the eminence of most of the contributors assures an interesting presentation.

FREDERICK CHRISTOPHER.

WOLBARST has compiled a most valuable treatise on *Gonococcal Infection in the Male*.[3] He states that the book is designed primarily to guide general practitioners in the proper recognition and management of the disease and its troublesome complications. Specialists and medical students might advantageously familiarize themselves with this text. The author has kept his subject matter completely up to date and his method of presentation is concise and easy to follow. Diagnosis and treatment have been classified according to the pathological involvement of the various anatomical structures.

A discussion on the proof of cure constitutes an interesting chapter. A final chapter by McDonagh of London in which he expresses his view on gonorrhœa accentuates the divergence of opinion in the two countries. VINCENT J. O'CONOR.

THE author of this book presents a very fine work in German on the subject of X-ray diagnosis in surgery.[4] He states that the material for the book was obtained in the University of Gottingen X-ray Department with the aid of the Pathological Department as well as the medical and surgical clinics of that institution.

The book is a splendid presentation of the subject, well written, and exceedingly well illustrated. It is an example of careful work in preparation of a difficult subject. The book may be recommended to any physician interested in X-ray, particularly those who can read the German text. The many illustrations with which the book abounds, are of such superior quality and demonstrate pathological changes so well that very little reading matter is required to explain the X-ray features. The volume is large and the subject is treated at length in a thorough manner. EDWARD S. BLAINE.

[1] PHYSICAL DIAGNOSIS. By Richard C. Cabot, M.D. 9th ed., rev. and enl. New York: William Wood and Company, 1927.

[2] PRACTICAL LECTURES ON THE SPECIALTIES OF MEDICINE AND SURGERY. Delivered under the Auspices of the Medical Society of the County of Kings, Brooklyn, N. Y. (Second Series 1924–1926. 568 pp.) New York: Paul B. Hoeber, 1927.

[3] GONOCOCCAL INFECTION IN THE MALE. By Abr. L. Wolbarst, M.D. With a chapter written by J. E. R. McDonagh, F.R.C.S. St. Louis: The C. V. Mosby Company, 1927.

[4] ROENTGENDIAGNOSTIK IN DER CHIRURGIE UND IHREN GRENZGEBIETEN. By Hermann Meyer, M.D. Berlin: Julius Springer, 1927

AS Sir Arthur Keith ends his foreword, *Healthy Growth*[1] is a most interesting book for all who are concerned with education—medical officers, headmasters, teachers, parents, educational authorities, and above all, statesmen who have the welfare of the nation at heart. It consists of several chapters on anthropometry in relation to educational progress, adaptation and development as indicated by entrance examinations and school work; technical chapters on special methods and physiology; consideration of overwork, over-pressure, and the ailing school child; and a correlation between the mental and physical activity of growing boys. It has five appendices devoted to statistical methods. It is an authoritative fundamental work in this most important field. PAUL STARR.

PRESENT clinical knowledge is summarized by Coope in his book on the diagnosis of pancreatic disease.[2] The book consists of two main parts—the first is a brief but helpful statement of anatomy, physiology, and clinical pictures; the second is an honest and somewhat disillusioning discussion of functional tests, under the heading of attempts to detect failure of "Discharge of Pancreatic Juice into the Duodenum." Intubation as a means of obtaining pancreatic secretion is described with a simple method for detecting lipase. A careful discussion of tests for ferments in the stool is given, the conclusion of which is that true creatorrhœa on a controlled diet is *the* test for pancreatic deficiency while true steatorrhœa or butter stools are rare and lesser amounts of fat in the stool may be due to other causes. The whole question is carefully examined. The importance of stool examinations on controlled diet and the use of indicators in the feces to control the time of transit through the gut are emphasized. The work is not impressive by reason of size but because of honest analysis. It is to be highly recommended as indicating methods of attack in a difficult and little known field. PAUL STARR.

THE new edition of this important *Treatise on Orthopædic Surgery*[3] brings it fully up to date, and maintains its position as the best modern textbook in this field. The subject matter is well and tersely presented, and includes all information essential to the practitioner or special worker. The descriptions of the most valuable original contributions of the distinguished author, namely, the bloodless reduction of fracture of the femoral neck, the open reconstruction operation upon the hip-joint, and the astragalectomy and backward displacement of the foot, might well receive more space and better illustrations. The second sentence of the first chapter, describing Pott's disease, is unsatisfactory and should be rewritten.

The condition called osteochondritis dissecans by Kœnig is still a stumbling block to the compositor. In the sixth edition of Whitman's book it was printed as "Dissicans," and in the present edition it appears as "Dessicans."

Kœnig's original observation was published in the *Deutsche Zeitschrift fur Chirurgie*, December 16, 1887, and refers to the condition as a *dissecirende* osteochondritis, or osteochondritis dissecans.

In many other instances the proof-reading has not been done in a manner commensurate with the importance of this textbook, which fact, however, does not detract from the intrinsic value of the work. EDWIN W. RYERSON.

[1] HEALTHY GROWTH; A STUDY OF THE RELATION BETWEEN THE MENTAL AND PHYSICAL DEVELOPMENT OF ADOLESCENT BOYS IN A PUBLIC DAY SCHOOL. By Alfred A. Mumford, M.D., with a foreword by Sir Arthur Keith, M.D., D.Sc., F.R.C.S., F.R.S. New York and London: Oxford University Press, 1927.

[2] THE DIAGNOSIS OF PANCREATIC DISEASE. By Robert Coope, M.D., B.Sc., M.R.C.P. New York and London: Oxford University Press, 1927.

[3] TREATISE ON ORTHOPÆDIC SURGERY. By Royal Whitman, M.D., M.R.C.S., F.A.C.S. 8th ed., thoroughly rev. Philadelphia: Lea & Febiger, 1927.

BOOKS RECEIVED

Books received are acknowledged in this department, and such acknowledgment must be regarded as a sufficient return for the courtesy of the sender. Selections will be made for review in the interests of our readers and as space permits.

NERVE TRACTS OF THE BRAIN AND CORD; ANATOMY, PHYSIOLOGY, APPLIED NEUROLOGY. By William Keiller, F.R.C.S. New York: The Macmillan Company, 1927.

BIOLOGIE UND PATHOLOGIE DES WEIBES; EIN HANDBUCH DER FRAUENHEILKUNDE UND GEBURTSHILFE. By Josef Halban and Ludwig Seitz. Lieferungen 39 and 40. Berlin and Wien: Urban & Schwarzenberg, 1927.

TECHNIQUE CHIRURGICALE OTO-RHINO-LARYNGOLOGIQUE. By E. J. Moure, G. Liebault, and G. Canuyt. No. 3. Paris: Gaston Doin et Cie, 1928.

DIAGNOSTIC CHIRURGICAL (Duplay-Rochard-Demoulin-Stern). 8th ed. by W. M. Stern. Paris: Gaston Doin et Cie, 1928.

HISTOLOGIE UND CHEMIE; DER LIPOIDE DER WEISZEN BLUTZELLEN UND IHRE BEZIEHUNG ZUR OXYDASENREAKTION, SOWIE UEBER DEN STAND DER MODERNEN HISTOLOGIE DER ZELLIPOIDE. By Dr. Ernest Sehrt. Leipzig: Georg Thieme, 1927.

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